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# Machinery.

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MACHINERY.

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# THE UNION IRON WORKS.

## THE FAMOUS SHIP YARDS OF THE PACIFIC COAST, WHERE THE OREGON AND OTHER NOTEWORTHY VESSELS HAVE BEEN BUILT.

J. Richards.

Among the phenomenal growths of organized industrial establishments in this country, none are more notable than the Union Iron Works at San Francisco, not only or so much in extent as in character. This growth of thirteen years has not been, as is usual, an expansion by expedients, but an orderly development on the lines of modern and advanced practice. There are no make-shifts, no use of antiquated implements. The progress from the beginning has been constant in implements, processes and results that compare favorably with and in some respects exceed what can be seen in the best European shipbuilding yards. The implements are more special in nature and adaptation and in a good many cases are of greater power and capacity than can be found elsewhere on this Continent. Of these more will be said in a future place. The main point of the Union Iron Works is situated about one mile southwest from the center of the city, at the Portrero, which is an old Spanish name for a pasture field or plain. The works cover 22 acres of ground—not only occupy, but cover, because there are nine acres of permanent buildings, not including what seems to be ship houses, but what are in fact huge gantrys that cover and surround each vessel during construction. These structures are mainly for handling purposes—that is to support traveling cranes operated by power that reach all points over, on and in the vessels. There is no carrying structural material up stages or lifting it to place by hand, and consequently none of the accidents so common when material is handled from scaffolding alone.

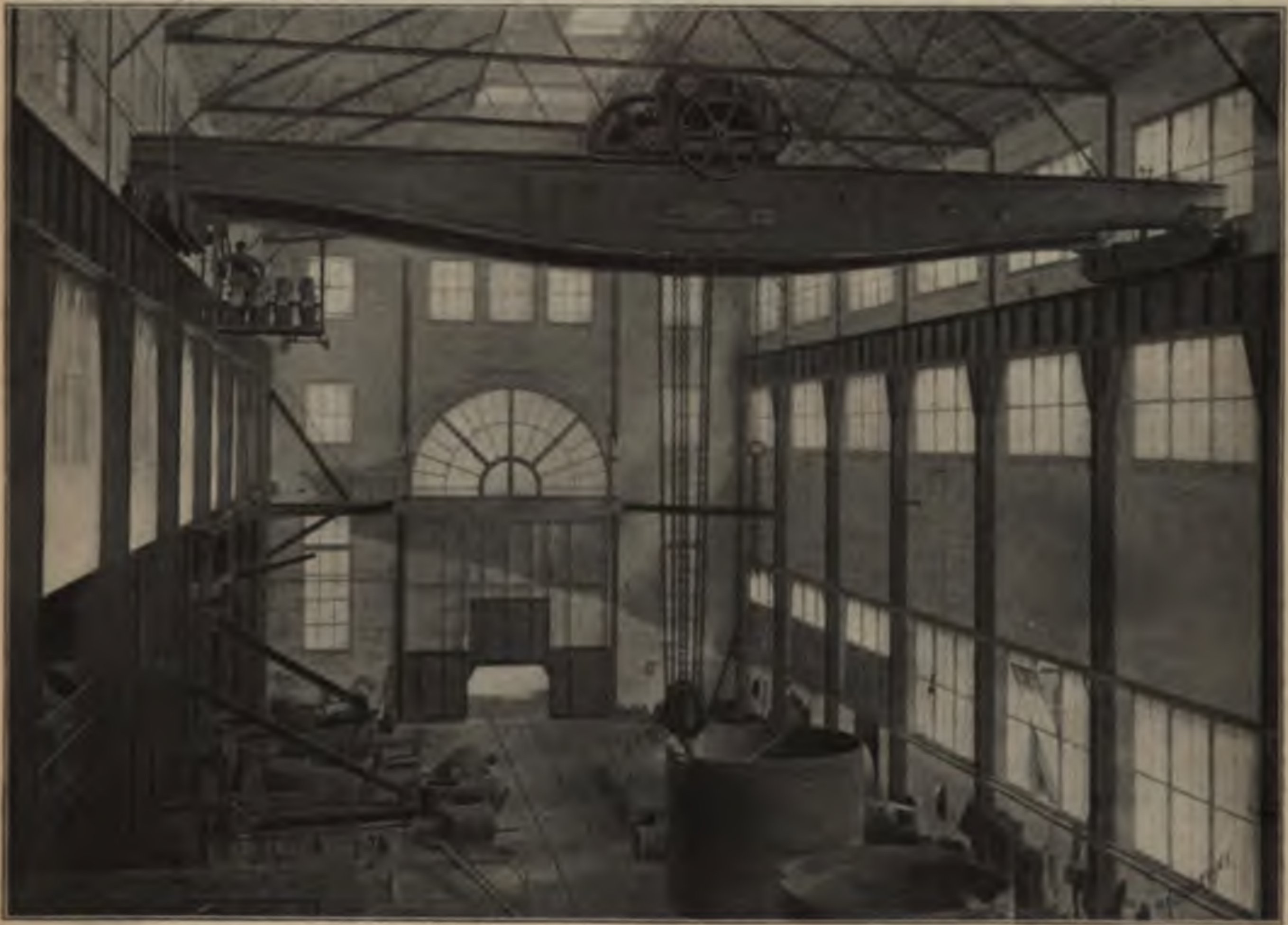

Fig. 1, showing the fifty-ton electric traveling cranes in the boiler shop. There are two of these cranes moving on the same ways, similar to the one shown in the illustration. The illustration also shows two jib drills for drilling the large boiler shells. The span of the large crane is 60 feet, the hoist 40 feet.

There are employed at this time 3,000 men that produce $3,000,000 of work in a year, $1,000,000 of which is general engineering work such as hydraulic and mining machinery, the latter being for the most part constructed in the City Works, where there is an auxiliary plant to accommodate from 150 to 200 men.

Of merchant shipping the facilities are equal to producing 30,000 tons a year. Last year 22,000 tons of mixed war and merchant vessels were launched, but comparisons in this direction will wholly fail to indicate the real producing power of the works, because the system and policy pursued as well as the circumstances are different from corresponding works in the East, where shipbuilding means to a great extent assembling instead of making. For example, a large war vessel contains in all from fifty to one hundred steam engines. Of these there are made in the Eastern works little more than the main propelling engines, all the auxiliaries for pumping, handling, lighting and so on being purchased from other firms or companies who make a specialty

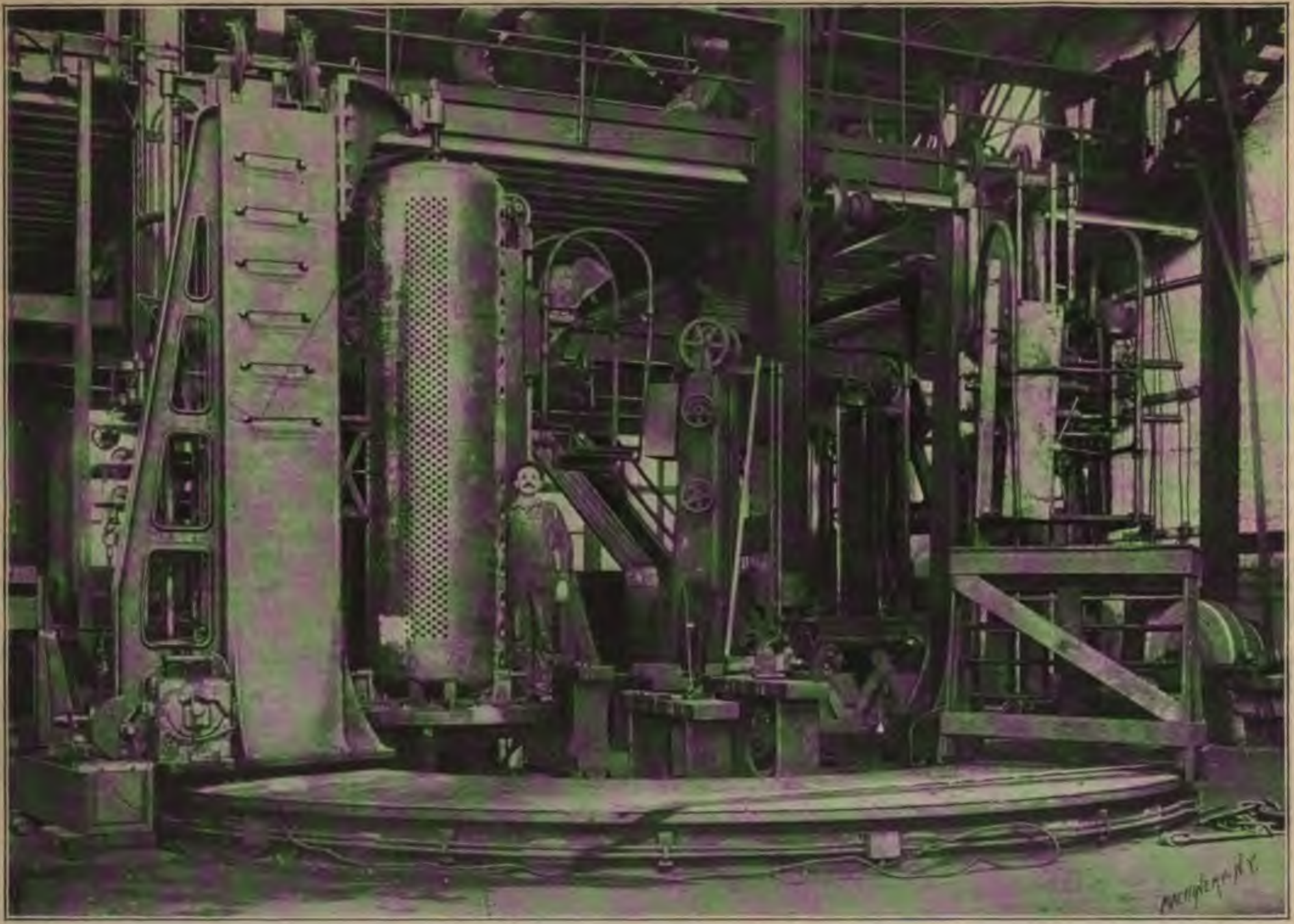

Fig. 2, showing the new boiler shell drilling machines in the boiler shop. These drilling stands traverse on a 30-foot circle and will receive a boiler shell of 18 feet diameter. There are five of these stands, some of them having three drills that can all operate at a time on a large shell, or they can operate separately on smaller shells. The upper drum of a Thornycroft boiler being drilled is shown on the left-hand side.

of these things; but at the Union Iron Works these are all made, as are the fittings of all kinds, down to water and steam cocks even, and all of the fittings in the electrical equipments.

Any skilled person in passing through the workshop can see that at least a fourth of all the men are engaged in making such things as are purchased in the Eastern shipbuilding yards. This calls for an extensive and varied equipment of tools, indicated by the fact that in one year (1897) there was added to the tool account $450,000, the largest amount perhaps ever purchased in the same length of time by any "going works" in this country.

An elaborate equipment of tools of a varied character is required in this manufacture and is provided by necessity and also by choice. There are no resources outside of the works nearer than two to three thousand miles away where supplies can be purchased.

Some time ago, when passing through a new building at the works in company with the manager and chief engineer, Mr. G. W. Dickie, we came upon a room filled with shelving all around piled with brass flanges, bored, faced and drilled ready for use. Mr. Dickie remarked, "We have just made up a stock of 25 tons or so. These are invoiced at 40 cents a pound in this finished state or worth $20,000."

Think of this amount of small brass flanges! But all other things are in proportion. A pile of boxes impeded our way—a car-load of candles that had just come in! On the day mentioned the stored stock in the works stood at $1,000,000. In the Eastern States these things, most of them, can be ordered when wanted and no such expensive stores are required. The merchandise stock account in iron, steel, rivets, tubes, plates, timber and so on, sometimes exceeds a million of dollars; that is an average.

The dry dock is of the hydraulic type and of unique construction, being raised by 36 hydraulic rams, 30 inches in diameter, all moving in unison. The dock is 450 feet long, 62 feet wide, raises 4,000 tons, and was erected at a cost of $400,000.

Among the handling tackle in the works are twenty-one traveling cranes; five of them raise 50 tons each and six of them 20 tons; sixteen are operated electrically.

This will do for figures and quantities, unless it be to add that it requires $3,000,000 of capital to carry on the business. In 1886 the ground on which the works stand was a swamp, or at least low foreshore with a substream of silt or depth like unto Chat Moss, in Lancashire, that Robert Stephenson filled in.

Most interesting of all is to conjecture where the skill came from that has organized this great industry and keeps it going abreast with the best practice in the Old World. The problem is not a difficult one, however. The whole industrial world has contributed, with the usual Scotchmen in the lead. The make-up is cosmopolitan. In the draughting room all the industrial nations are represented. It reminds one of Great Britain, where it is said they do not ask where one was born or the color of his skin, but what does he know and what can he do?

To compare with the Clyde Yards, where metal ship building has its head and center, there is some difference in methods and means, and while there is always some new point to be seen there is not to be found in any European yard a general average of efficiency that will excel the Union Iron Works.

This is natural and to be expected. An establishment reared on the "Eclectic" system should be the best and this one is, in all general features. If there is better it is in Ireland, at Belfast, but this works (Harlan and Wolff's) I have not seen for many years, so cannot compare at this time.

The increased rate, or the reduced cost, of cutting, fitting and finishing metal work has immensely increased during twenty years past and the major part of the increase falls in the last decade. This progress is commonly ascribed to new processes or methods, but this is only one factor out of many. Heavier and stronger tools, better made, is a principal cause. Better and more uniform material another. Duplication a third and indeed greatest of all. We are not wiser than our progenitors, but have better opportunities. Any one of half a dozen machine tool-makers at the beginning of this century, that could be named, did more in original design than as many hundreds of our time; that is, did more, in a general way, if their work is measured by the comparative effect produced. Then the field was narrow and opportunity was wide; now the field is wide and opportunity is narrow. The work of the individual is now lost in a sea of industrial turmoil and must be estimated on a different basis altogether.

A little improvement that augments the out-put of a thousand lathes ten per cent. is now more important than one that doubles the capacity of a hundred lathes, or rather is the same thing in an economical sense.

The principal feature of the Union Iron Works is, as has been intimated, in their implement equipment and mainly in tools made in the works, because not procurable elsewhere or too heavy to be profitably transported. To illustrate this there have been selected some of the large special implements shown in the photo-plates herewith and briefly described in the explanatory notes. Except in two cases the implements shown were made in the works. Some of the largest implements in the machine shop are omitted because they could not be photographed. Among these are a radial drilling machine, made by the Shanks, at Glasgow, that weighs more than 100 tons, and horizontal boring machines of great capacity.

These notes respecting the Union Iron Works were suggested by the fact that in a recent article on American ship-building yards that recently appeared in a popular magazine* the writer did not think it worth while to mention these works, which reminds us of the fact that about twenty years ago an inquiry was sent out to the Pacific coast by the government officers inquiring whether castings of large size could be made there, and in answer found out that the Risdon Iron Works at San Francisco had the heaviest equipment in this country for moulding, pouring and handling castings. This works had then in their foundry fifteen hydraulic cranes and melting capacity beyond any firm in the East at that time.

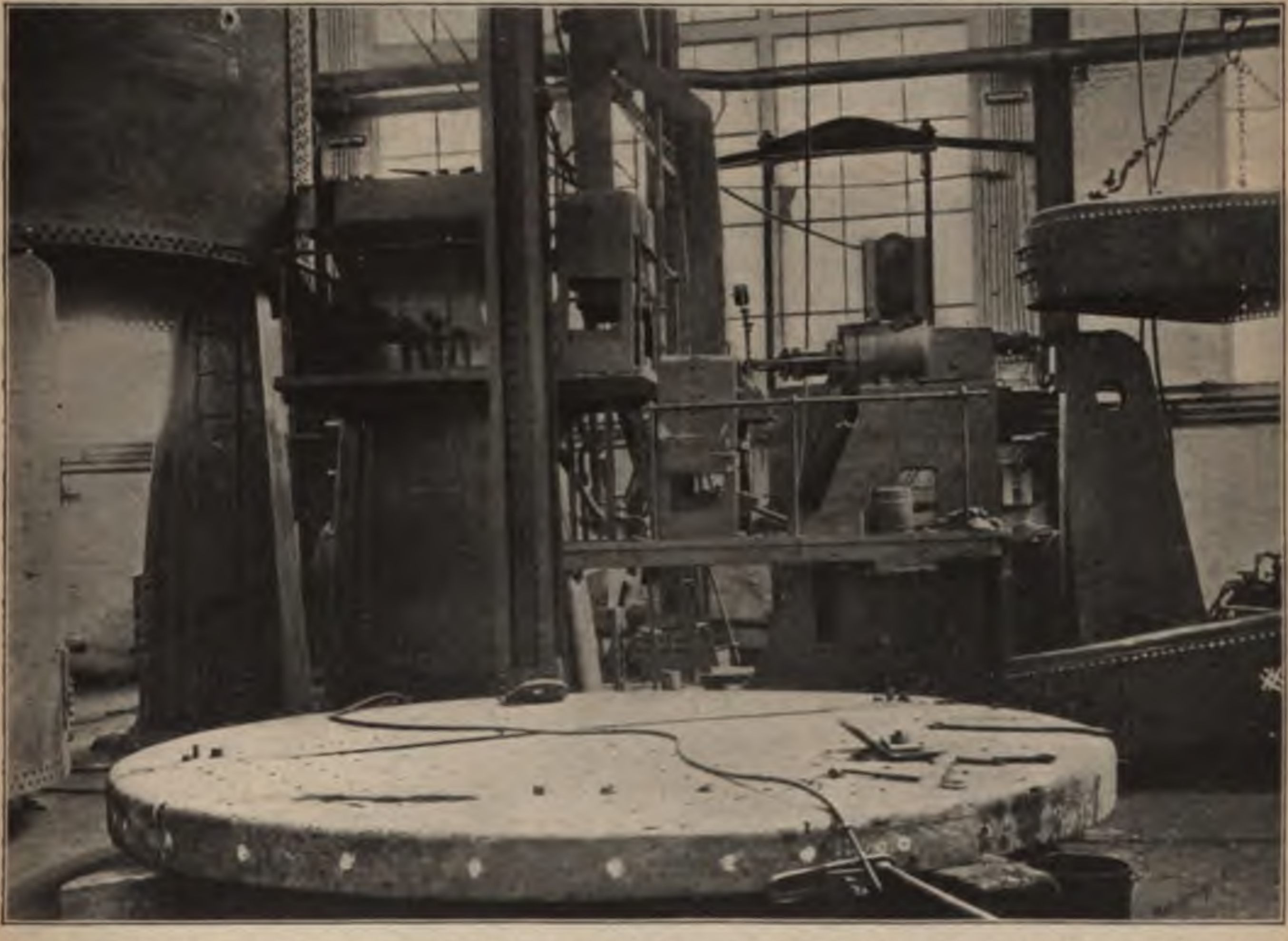

Fig. 3, showing large hydraulic riveting machines in the boiler shop. The one on the left has a gap of 12 feet, and the one on the right hand side, the first one made by the company, has a gap of 8 feet in depth. Both are capable of driving 1¼-inch rivets.

The writer, who came to the Pacific coast about that time, found in the works above-named an organized machine for pumping water 2,000 feet high that cost $250,000, and occupied a space 60 x 30 x 17 feet and constructed under a guarantee of performance that made it the boldest venture in machine construction he had ever seen in this or other country.

Of these remarks concerning the Union Iron Works, it may be said there is but the one shipyard at San Francisco; but there are more and I will venture the claim that the Fulton Engineering and Shipbuilding Works, the next in rank, have constructed more sea-going steam vessels in the last decade than any similar works on the Atlantic coast—not less than 125, or about 16 each year. These were mainly small vessels in the coast trade. The bay and ferry steamers are all built here and of these no mention is required. The ferry boats have no parallel that I am aware of.

* * *

We have often pointed out that good machine design depends more upon good judgment and practical experience than upon an exact knowledge of mathematics and the actual stresses and strains that occur in the operation of machinery. It is more a question of making parts so they will not deflect appreciably or wear out rapidly than of their actual breaking strength. There are cases, however, even in the simplest work, where such theoretical knowledge discounts practical judgment ten times over. A case in point is that of the gangplank of one of the Mount Desert (Me.) ferryboats, which broke while a large crowd was passing over it on Sunday, August 6, and precipitated a score of people to their death. This particular plank may and may not have been carefully proportioned for the maximum load that it might have to sustain, but if it was built according to the methods usually adopted for details of this or a similar character it was thought sufficient to leave the construction to some carpenter, who, while he may have been a good carpenter, probably lacked just the knowledge required to design a gangplank capable of safely bearing a crowd of people. While in many instances it is not necessary to make calculations for strength, it is unsafe not to do so where life or property is at stake, however unimportant the detail may seem to be.

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*Metropolitan Magazine, June, 1899. "A New Era in American Shipbuilding."

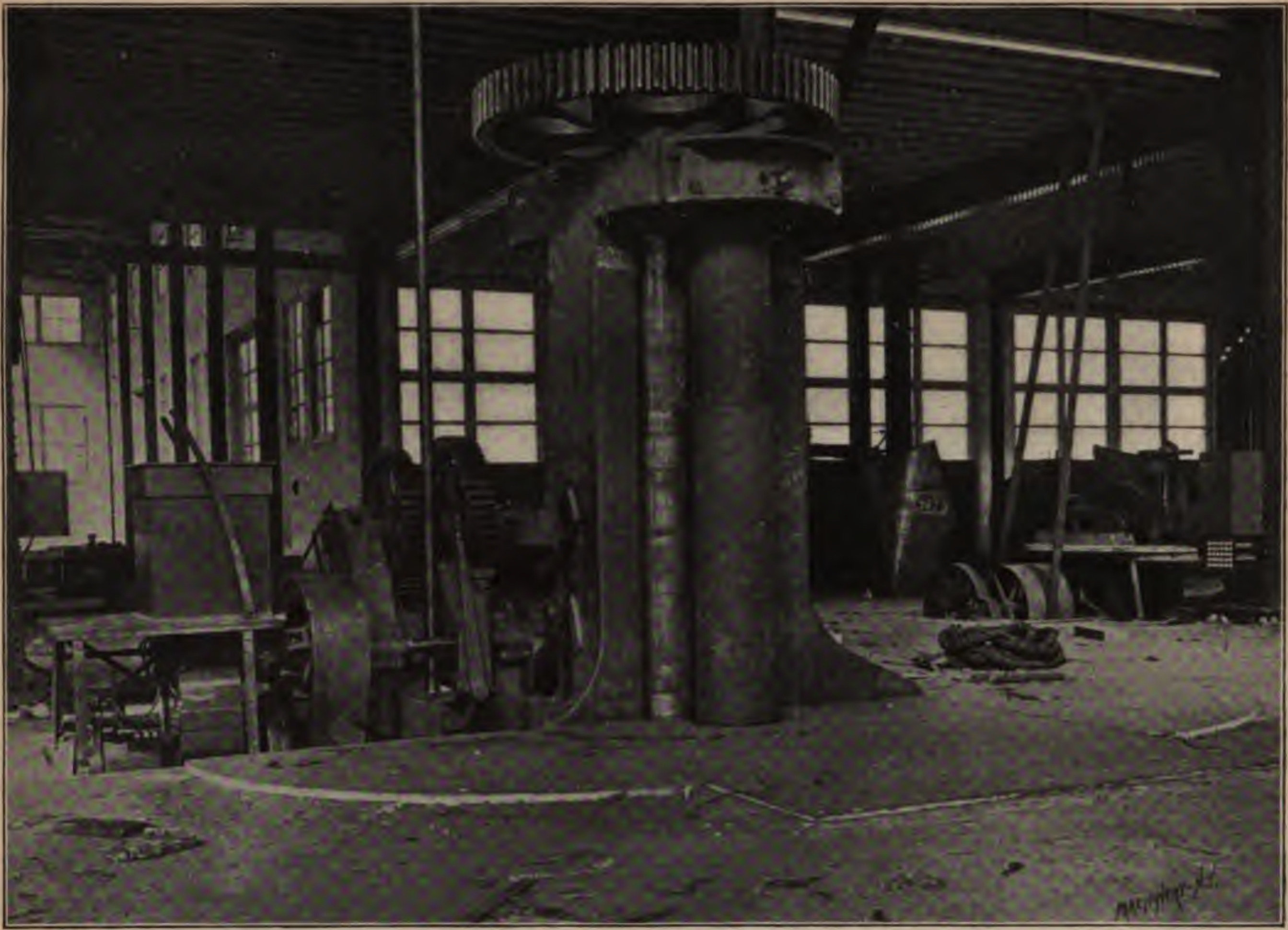


Fig. 4, showing the vertical bending rollers in the boiler shop. These are operated, as all the working tools in the boiler shop are, by electric motors. The motor in this case is shown on the left-hand side. These rollers take in 1¼-inch plates 12 feet wide.

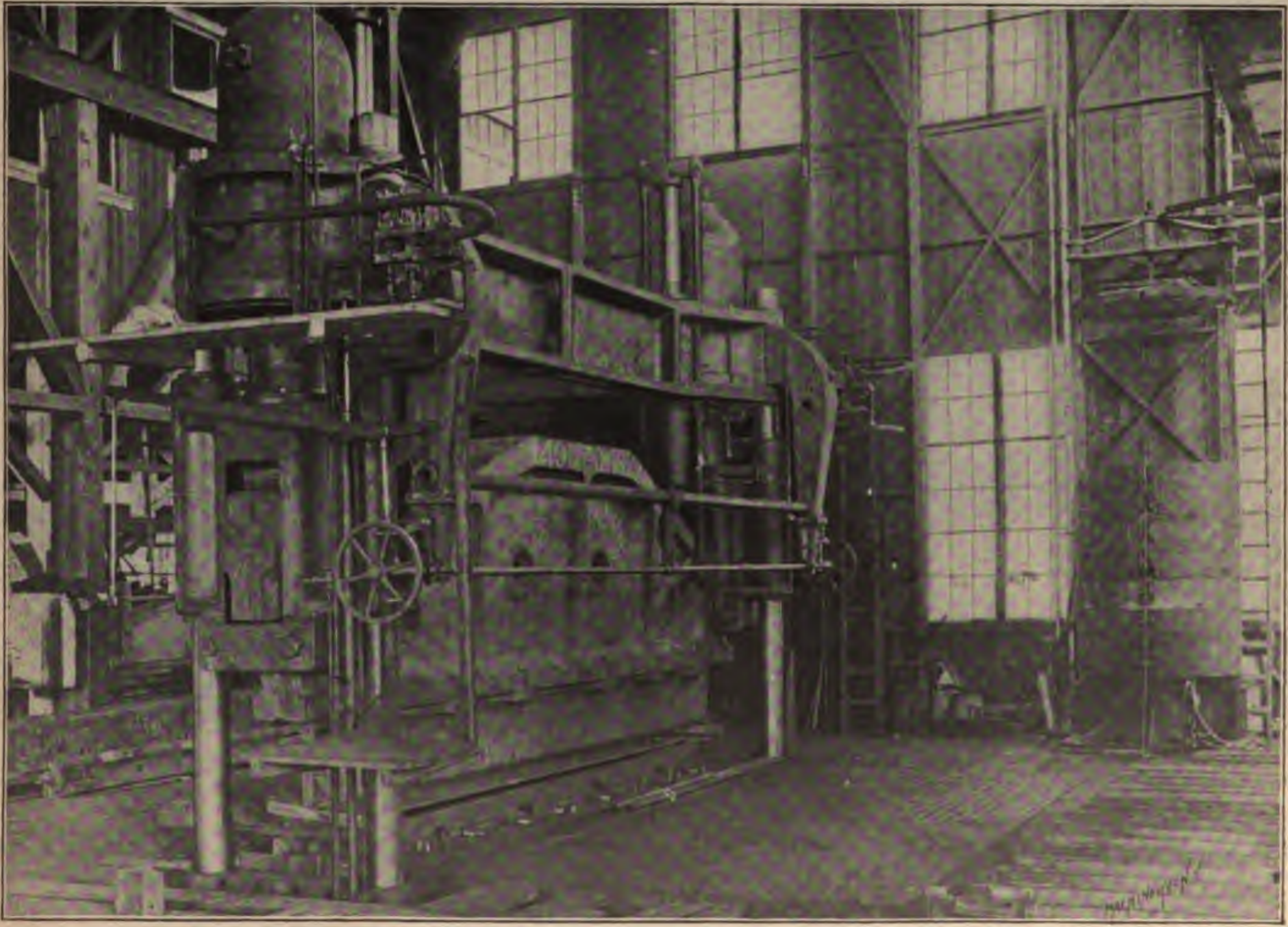


Fig. 5, showing a hydraulic flanging press for flanging and shaping cold steel plates in the shipyard. This press exerts a pressure of 600 ons and can readily bend 4-inch steel plate cold. This is one of the most important tools in the works, and is kept steadily at work.

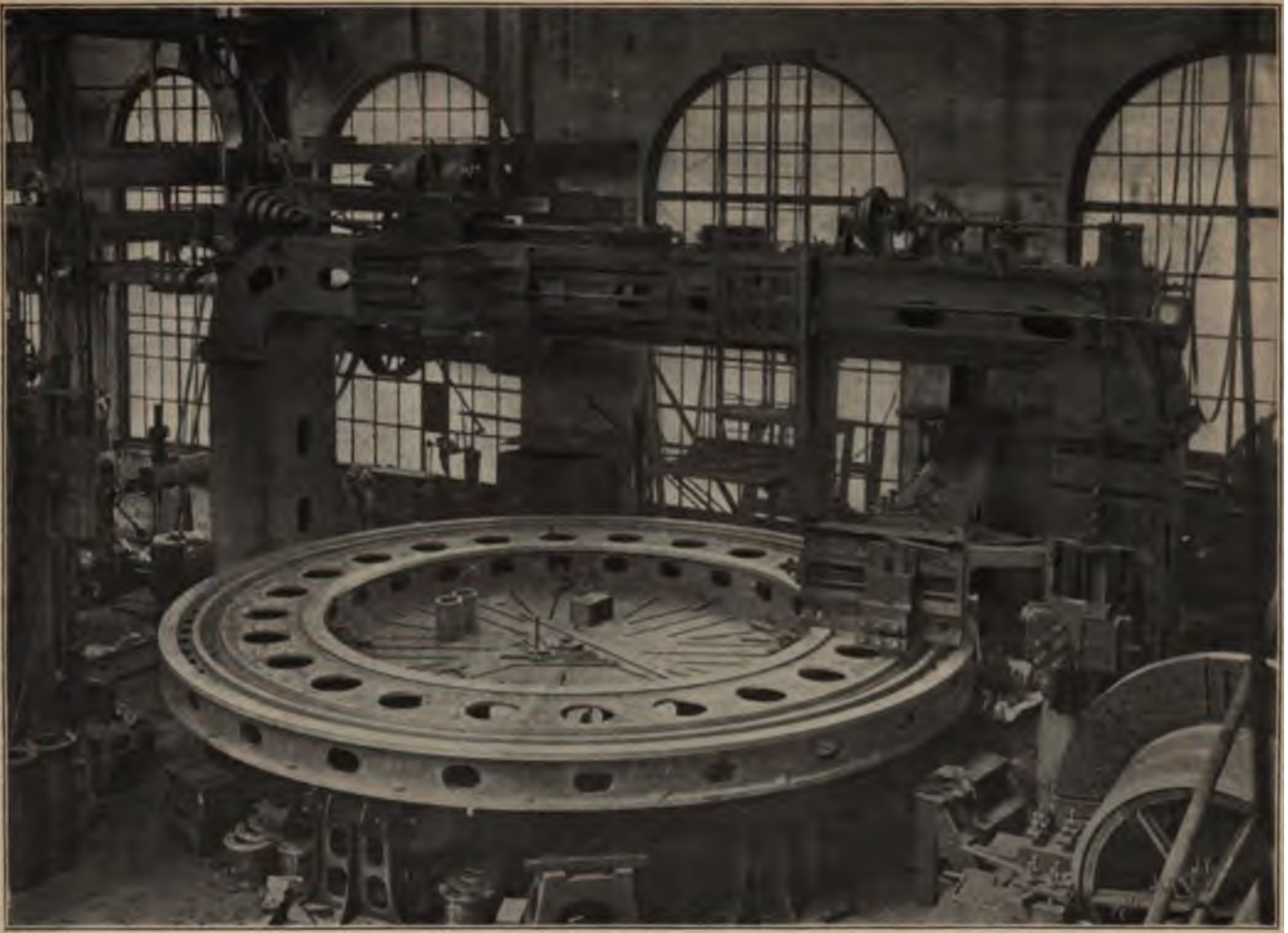


Fig. 6, showing the large horizontal turning mill in the machine shop. This machine turns to 30 feet in diameter. The base ring for th large drilling machine in the boiler shop is shown being machined in this tool. The diameter of the ring is 30 feet.

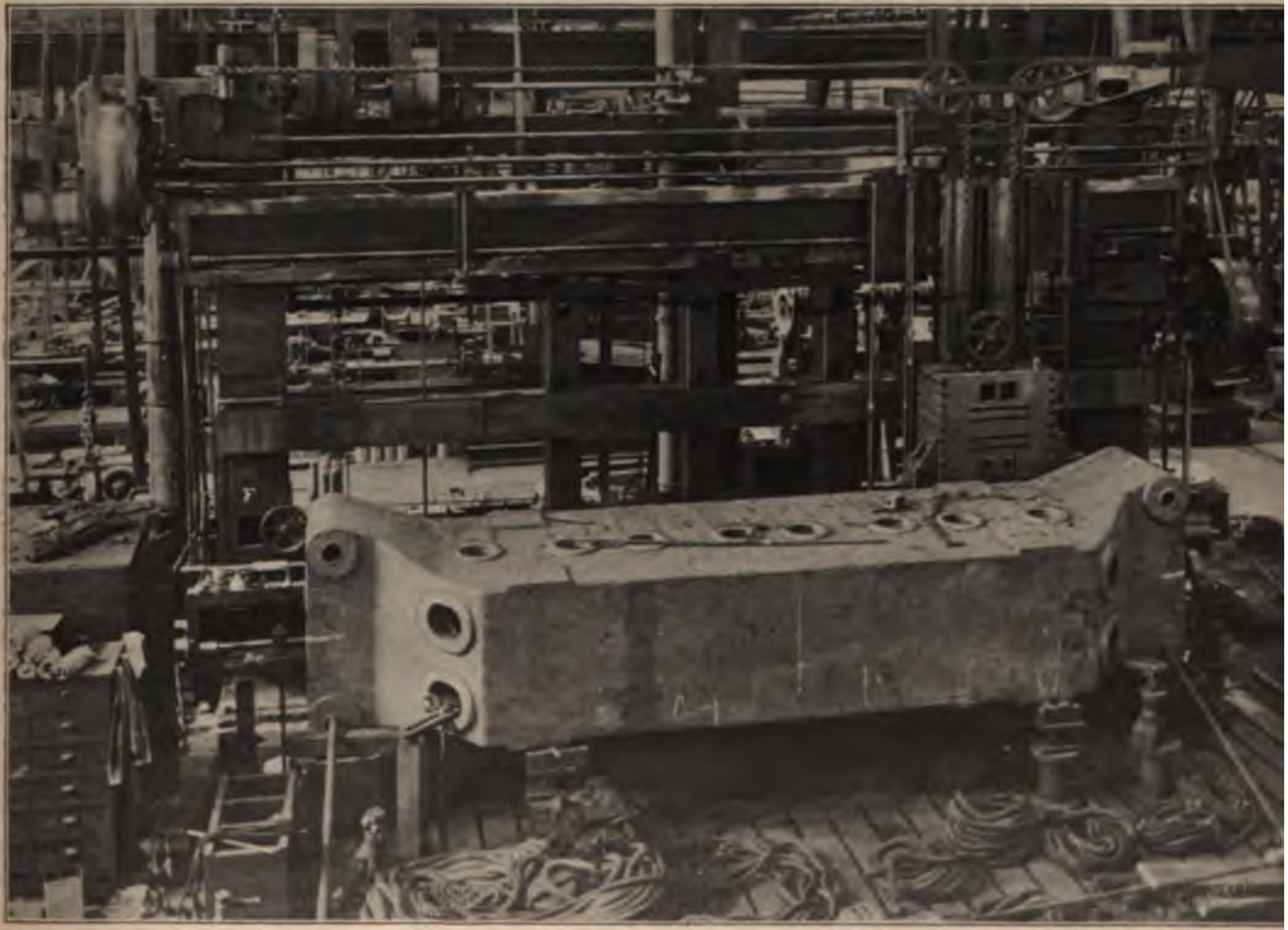


Fig. 7, showing a traversing planing machine with a horizontal traverse of 16 feet. It is shown operating on the bed plate of a lar hydraulic flanging press; the casting being operated on weighs 62 tons and is 26 feet long, 6 feet wide and 8 feet deep.

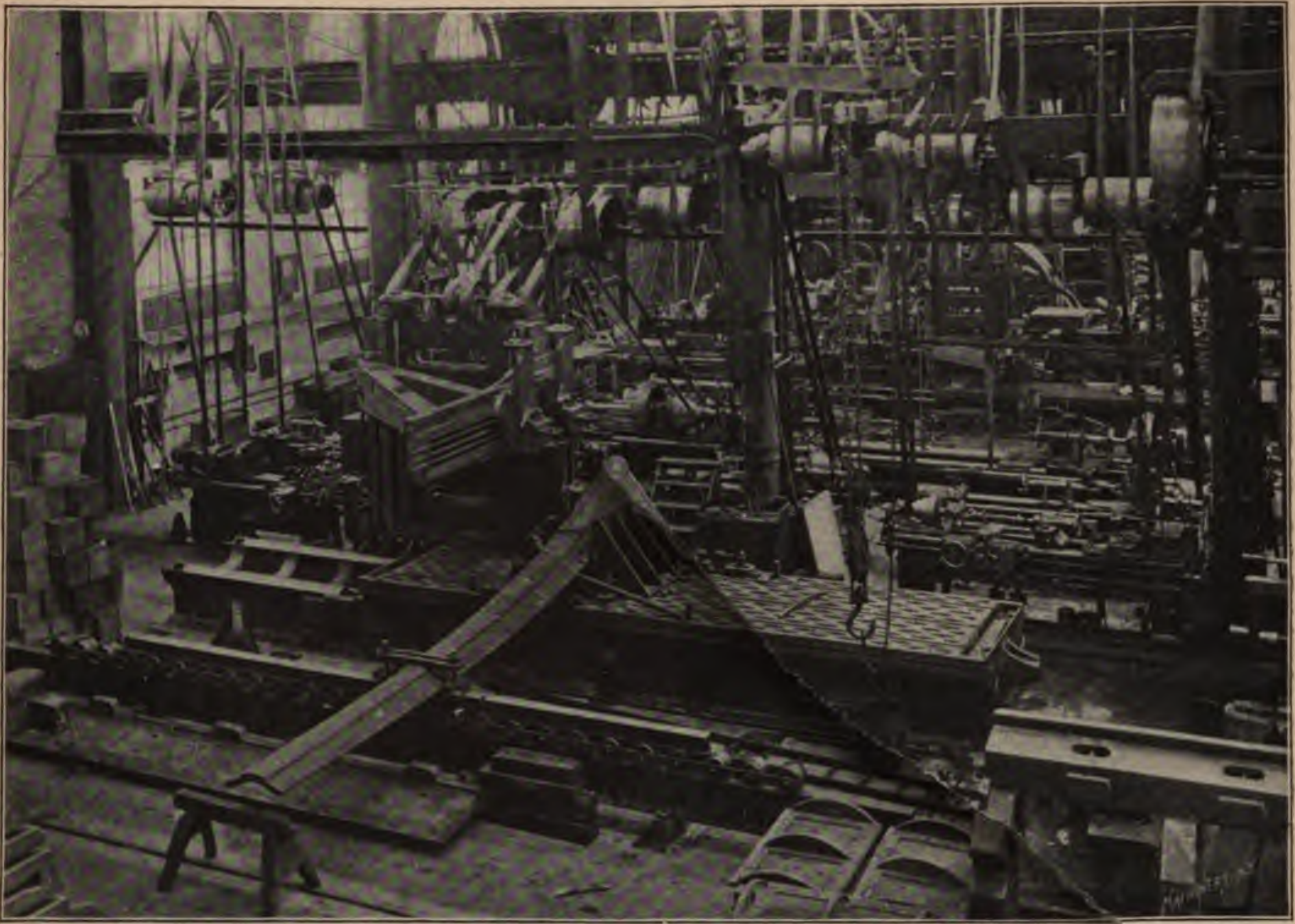


Fig. 8, showing the open side planer, of which there are twelve in use. This is shown operating on the upper portion of the ram of the new battleship Ohio.

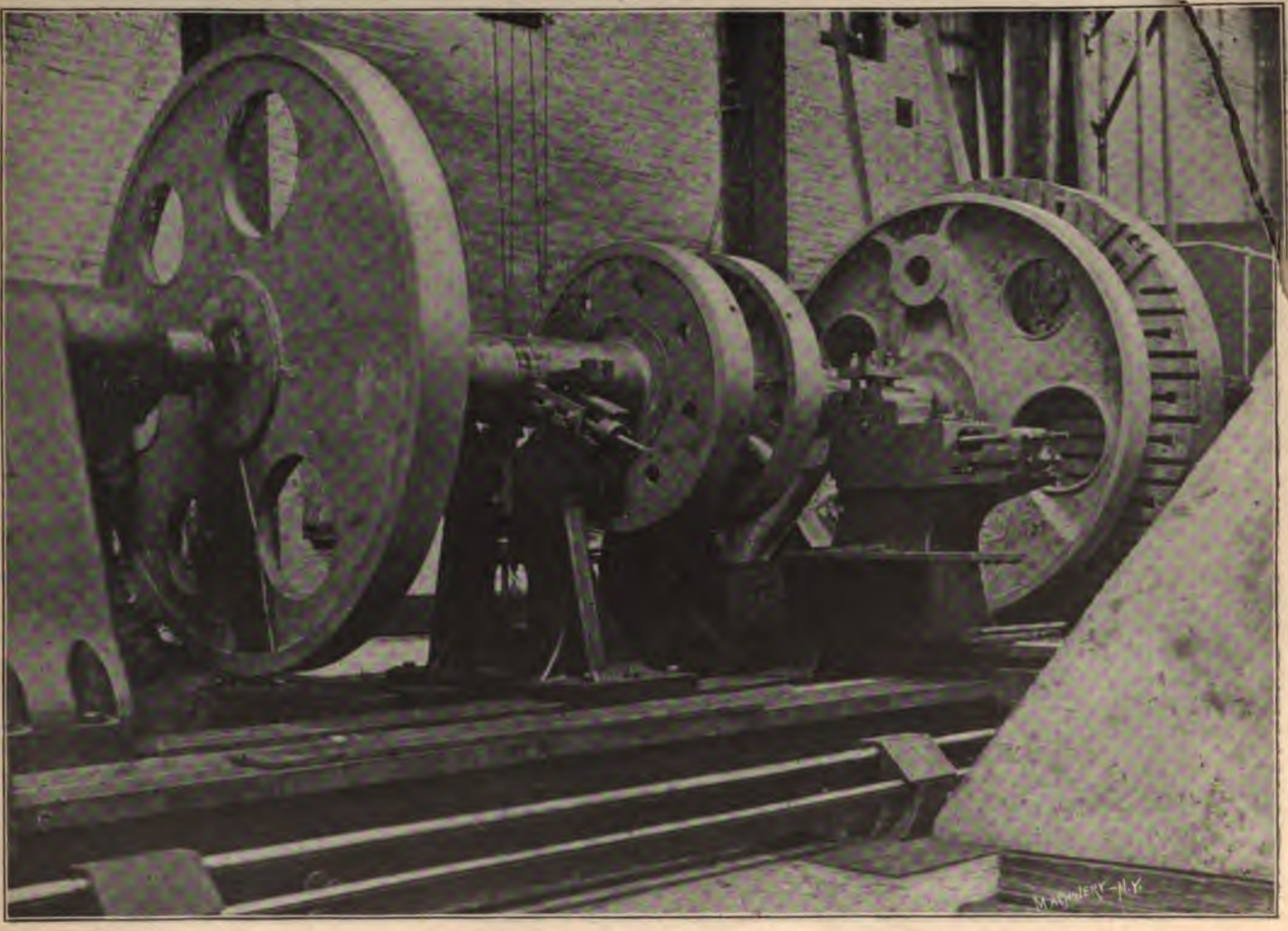


Fig. 9, showing a new lathe recently added in the machine shop. The shaft with the two crank discs, as shown in the lathe, is 34 feet in length, 24 inches in d [illegible] re 10 feet 6 inches in diameter.

Machinery New York

It was in a small shop in a small country town that this company was located. In a rural district the people will patronize the small shop before they will the large one. Farmers dislike shop system; they abhor a shop with an office; they care nothing for a clerk with white cuffs; they wish to find the man with the overalls. So Jones started his shop to cater to the wants of the farmers and lumbermen and said to himself; "Now for a name for my shop. I know something about engines and I propose to build a few when the repair work is not crowding, so I will call my concern an 'Engineering Co.'. As I cannot hope to do everything that larger and more complete shops can do, since my facilities are limited, I will call myself 'The Jones Engineering Co., Limited,' and I consider it no disgrace, either, since I read of big concerns like the Carnegie Iron Works who are not ashamed to admit that they are 'limited' and state it so in their firm name!"

So Jones started in business with a firm name and a magnificent ignorance of its meaning, and a half a dozen men. Like the walls of Sparta every man was a brick. Each workman represented half a dozen trades—patternmaking, blacksmithing, plumbing,—in short, all the necessary manufacturing trades except draughting, and thereby hangs this tale. "Aint running no picter gallery," said Jones. "Now you go to a big concern and get a job of that kind done and they will send it into their draughting office and a lot of high priced fellars get together and chew over how the shade lines ought to run and all that sort of thing, and the customer has all that to pay for. Now I'll show you how we do it. Here's a duffer as wants a truss-rod made and I've got all the dimensions right here in my head; wouldn't give shucks for a mechanic who couldn't carry figures or do sums in his head." While he was talking he was laborously marking out the dimensions for a truss-rod on a board and sprinkled it with figures after much wetting of the pencil in his mouth. "Now my best blacksmith is doing some pattern work that I am in a hurry for so Joe'll have to do it when he gets back from that tin-roofing job, but he has got a good working drawing and he can't go wrong if he tries." Nevertheless when the job was done it was not at all in accordance with Jones' idea of what was wanted. The eyes instead of standing parallel to each other both lay in the same plane, as shown in Fig. 2, which was in fact just what Jones' sketch showed and in this fact lay the blacksmith's refuge. After some wordy argument Jones was obliged to admit that the sketch *might be* misconstrued, but if he had been doing the forging he could have got what was wanted even with that drawing. "But never mind, the fork is long enough so we can give the eye a quarter twist and still get out of it cheaper than to make any high-art drawing." The twist was made as in Fig. 3, and the job delivered to the customer who was a bridge engineer erecting a bridge near by. Jones had a dislike for "scientific fellars" and their educated ways, and he was not at all pleased to see this man carefully caliper the rod in several places, and he was nearly furious to have him declare that the stock in the two forks was too light for the body of the rod. "Takes just one half of the load," Jones explained, "so we made it just half the size, the main rod is 2 in. iron and the two forks are 1 in. each, just the same, d'ye see?" The customer smiled a bit at this explanation. Erecting work in the field had made him resourceful, so taking a rule from his pocket he measured 2 inches diagonally across the corner of the table as shown in Fig. 4. "Now," said he, "let this line represent the diameter of the large rod, then the distances each way from the square corner of the table to this line would each represent the two smaller rods which in this case would be 1 13-32 in. each." "Well, I swan," said Jones, "that's something like. Say! I'd like to get hold of a book with such recipes as that in it. I s'pose you get those things out of books, don't you?" "That little trick," said the stranger, "is older than the English language, yet I doubt if it was ever printed in any book in just that form, and I doubt if it would help you any if you had the book where it came from; it is the *knowledge* which is needed, then one can make the application at any time or in any form." "Say, stranger," said Jones, "if you should lose your job at any time jest let me know and I'll see what I can do for you; I'd kinder like to have a man round that's handy with his book larning."

W. H. S.

FIG. 1.

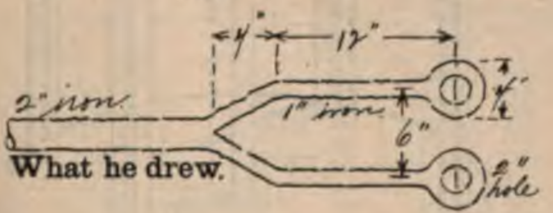


FIG. 2.

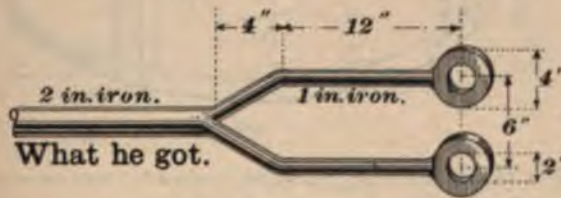
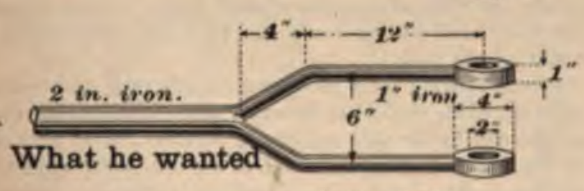
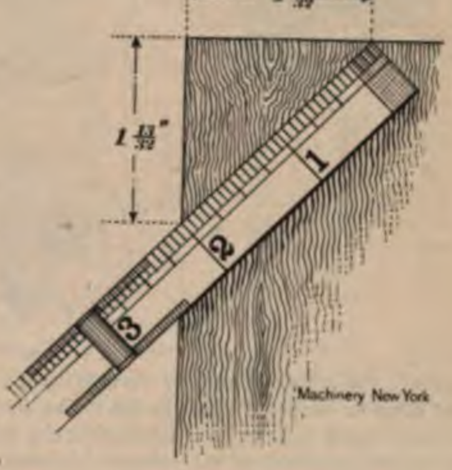


FIG. 3.



Machinery New York



Machinery New York

FIG. 4.

* * *

A recent number of the "Electrical Review" (English) illustrates Humpage's gearing, which, it will be remembered, was described in our February number, and incidentally (and unintentionally) pays a tribute to American methods. This gearing is a form of epicyclic bevel gearing used for back-gears, and the teeth are planed on a Gleason gear-planer. The review says: "This gearing is clearly a machine which will repay the cost of very accurate construction, and the makers are fully alive to this. Machines have only recently been available for cutting accurate bevel gears, and the very best makers of gears, even in America, have been content with the rough approximation to the geometrical form obtained by cutting the teeth with parallel cutters, and doing something or other afterwards to make them look a little better."

## ITEMS OF MECHANICAL INTEREST.

### NOTES GLEANED FROM OUR CONTEMPORARIES.

### SMILLIES'S THREAD TOOL.

An English patent was recently granted to Mr. John D. Millie, of Lanarkshire, for an improvement in thread cutting tools.

This invention relates to tools for cutting screw threads on bolts, spindles, and the like, and it has for its object to provide in substitution for the ordinary screw cutting dies, a tool the cutters of which have a cutting edge which may be readily renewed or sharpened when worn. It is clearly illustrated by the accompanying drawings, Fig. 1 being a longitudinal vertical section of the tool; Fig. 2 a front elevation, and Fig. 3 a transverse vertical section on the line x—x in the direction of the arrows. The tool comprises a holder A, having a central orifice A1 through which the bolt or spindle operated on passes. The holder carries a circular disc B on which the cutters C are centered. These cutters are held by studs C1 centered through slots B1 eccentric to the center of the disc B, and pass through radial slots A2 in the holder A, the slots A2 and B1 permitting the cutters to be advanced upon or retracted from the job. The studs C1 have nuts C2 on their inner ends so that the head of the studs can be drawn hard against the faces of the cutters C in order to clamp in position with their cutting edges against the work. A bolt D is provided which passes through a hole in the disc B and through a slot A3 in the holder A, and serves to clamp the disc B to the holder A when the desired adjustment or advancement of the cutters has been effected, which clamping is done by means of an internal threaded handle E. The cutters consist each of a circular disc cut away at C3 to provide a cutting edge at one point of the circumference of the disc. The cutting threads are formed around the circumference of the cutting disc C, which arrangement permits of the renewing of the cutting edge of the disc by grinding away a portion of the part C3 radially, thus bringing the new cutting points on to a fresh portion of the cutting threads.

Fig. 1

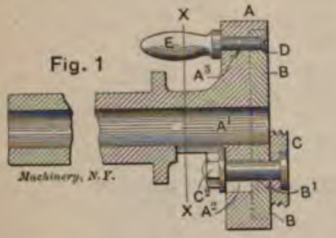


Fig. 2

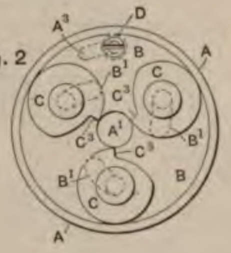
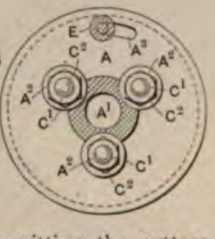


Fig. 3



### A ROLLER THRUST BEARING.

In a paper read before the Institution of Naval Architects, England, Mr. F. von Kodolitsch describes the results of some shop experiments for determining the difference in efficiency between an ordinary thrust bearing and the roller thrust bearing shown in the accompanying cut. The two experiments could in this case be made in the same bearing, it being so constructed, as reference to the cut will show, that the thrust is taken by rollers when running in one direction, but when going the opposite way is taken on white metal rings.

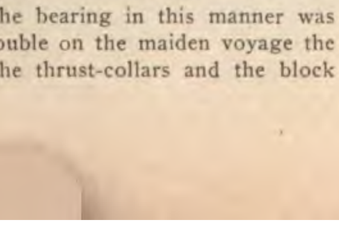


FIG. 4.

The object of constructing the bearing in this manner was that in case the rollers gave trouble on the maiden voyage the section of the shaft carrying the thrust-collars and the block could be turned around, thus converting it into an ordinary bearing.

The results of the tests showed that with a marine engine of 600 H.P., running at 136 rotations per minute, the loss in the plain bearing was 29.75 H.P., whereas the roller bearing only showed a loss of 2.4 H.P. when working under the same load.

Notwithstanding the apparent gain in efficiency, the arrangement scarcely appears feasible for the arduous service required of these bearings in actual service, for while it is highly desirable to reduce the losses from friction to the minimum, the safety and durability of such an apparatus must necessarily be considered first.

### A REVOLVING TOOL RACK.

The *Railway Review* recently described a convenient rack for blacksmith tools which is in use in a western railway shop.

In the majority of blacksmith shops, it is the usual practice to have the heavier class of tools, such as larger sizes of tongs, dies or formers of various kinds, sets, flats, etc., and especially tools that are used under the steam and "Bradley" hammers, stacked up in some out-of-the-way corner. When one of these tools is wanted the helper is sent to rummage through the pile to find it. The task of hunting for these tools is not so very troublesome when waiting for a piece to take a heat, and there is nothing else for the helper to do, but if there happens to be a heat on the anvil waiting for the tool to be found, which has occurred more than once, there is considerable annoyance and loss of time on the part of all connected with the job. The piling of these tools in corners and out-of-the-way places does not improve the order and convenience of the blacksmith shop. Fig 5 is a blacksmith shop revolving tool rack made to contain principally the class of tools mentioned above. It can be easily understood how quickly tools can be found when hung on the hooks of the rack.

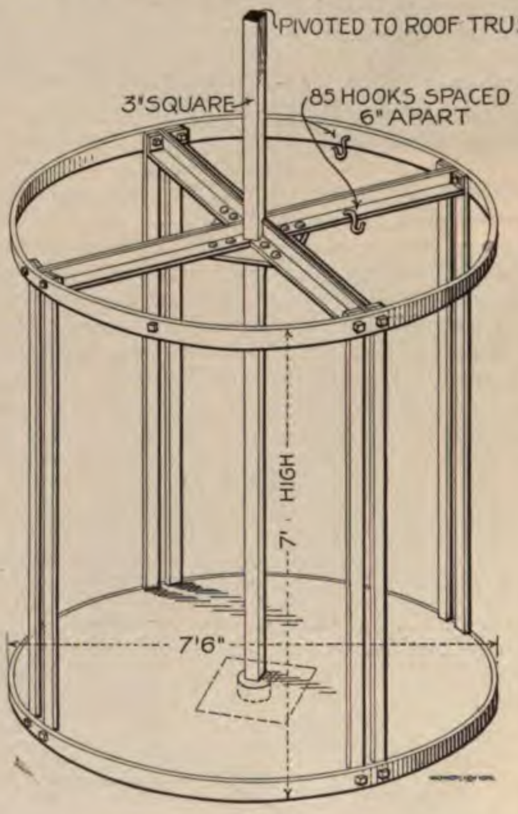


FIG. 5

A man looking for a tool hung on this rack with many others can very likely find what he wants while approaching the rack—go directly to the tool and get it, whereas, when they are piled on the floor in a heap he is able to see only those tools that form the top layer of the pile. There are eighty-five hooks spaced six inches apart to hang tools upon. Such tools as cannot, conveniently, be hung on the hooks are placed on the lower portion or floor of the rack. As this rack is pivoted on a ball bearing thrust and can be easily revolved it is not necessary to place it where it will be accessible from all sides, but can be put in some convenient spot that is accessible from one side only.

## FAMILIAR SUBJECTS IN MECHANICS.—4.

### BELTING AND PULLEYS (Continued.)

SAMUEL WEBBER.

I find, in looking over my old records, much more material on the subject of belts and pulleys, and will therefore select more that may prove of interest to the readers of MACHINERY.

The tests of 12-inch belts, noted in my last letter, were continued with trials of a rubber belt, under different loads, and as there was no "slip" apparent, on iron pulleys, until the last trial, when the belt "jumped" instantly from the pulley it was not tried on either wood or paper.

This 3-ply belt, 31 feet long, 12 inches wide, weighed 37 pounds, but we had to cut out 11½ inches to get a strain of 43½ pounds per inch upon it. Under this strain it gave the following results:

TABLE I

| Load on Brake, lbs. | R. P. M. | H. P. | Slip. | Ft. Belt per min. | Coeff. Friction. | Ft. Belt per H. P. per in. | Strain per inch in lbs. |
|---|---|---|---|---|---|---|---|
| 60 | 117.6 | 7.05 | 0 | 730 | .303 | 1258 | 43½ |
| 70 | 115.4 | 8.07 | 0 | 725 | .354 | 1078 | 43½ |
| 75 | Slipped | off. | | | | | |
| | | | | Cut out | 6 inches; | strained | to 62½ |
| 80 | 115.4 | 9.23 | 0 | 725 | .280 | 942 | 62½ |
| 90 | 115.4 | 10.38 | 0 | 725 | .315 | 837 | 62½ |
| 100 | 115. | 11.54 | 0 | 722 | .352 | 751 | 62½ |
| 110 | 113.2 | 14.45 | 0 | 711 | .386 | 685 | 62½ |
| 120 | 111. | 13.32 | 0 | 697 | .426 | 627 | 62½ |
| 130 | 105. | 13.68 | 0 | 660 | .456 | 579 | 62½ |
| 140 | Belt | sprang | off pulley. | | | | |

Four inches more were then cut out of the belt, which brought it together with a strain of 83 1-3 pounds per inch, with these results:

| Load on Brake, lbs. | R. P. M. | H. P. | Slip. | Ft. Belt per min. | Coeff. Friction. | Ft. Belt per H. P. per in. | Strain per inch in lbs. |
|---|---|---|---|---|---|---|---|
| 80 | 114.3 | 9.14 | 0 | 718 | .210 | 944 | 83⅓ |
| 90 | 114.3 | 10.90 | 0 | 718 | .237 | 837 | 83⅓ |
| 100 | 114.3 | 11.48 | 0 | 718 | .263 | 754 | 83⅓ |
| 110 | 113.9 | 12.45 | 0 | 711 | .290 | 685 | 83⅓ |
| 120 | 113.2 | 13.58 | 0 | 711 | .315 | 628 | 83⅓ |
| 130 | 112.1 | 14.57 | 0 | 704 | .341 | 580 | 83⅓ |
| 140 | 111. | 15.54 | 0 | 697 | .363 | 538 | 83⅓ |
| 150 | 109. | 16.35 | 0 | 685 | .387 | 505 | 83⅓ |
| 160 | 109. | 17.44 | 0 | 685 | .426 | 471 | 83⅓ |
| 170 | 106.7 | 18.14 | 0 | 670 | .447 | 443 | 83⅓ |
| 180 | 103.4 | 18.61 | 0 | 650 | .472 | 419 | 83⅓ |
| 190 | Belt | sprang | from pull | ey. | | | |

This last trial seemed to exhaust the capacity of the belt, as the rubber had begun to peel from the canvas and prevented any further trials.

TABLE II. COTTON LEATHER BELT.

IRON PULLEYS.

| Load on Brake, lbs. | R. P. M. | H. P. | Slip. | Ft. Belt per min. | Coeff. Friction. | Ft Belt per H. P. per in. | Strain per inch in lbs. |
|---|---|---|---|---|---|---|---|
| 100 | 120. | 12. | 0 | 754 | .262 | 754 | 83⅓ |
| 110 | 117.6 | 12.94 | 0 | 739 | .289 | 695 | 83⅓ |
| 120 | 116.5 | 13.28 | 0 | 732 | .315 | 698 | 83⅓ |
| 130 | 115.4 | 15. | 0 | 725 | .341 | 580 | 83⅓ |
| 140 | 114.3 | 16. | 0 | 718 | .368 | 538 | 83⅓ |
| 150 | 113.9 | 16.98 | 0 | 711 | .394 | 502 | 83⅓ |
| 160 | 111. | 17.77 | 1.00 | 707 | .415 | 477 | 83⅓ |
| 170 | 110. | 18.70 | 2.22 | 707 | .436 | 453 | 83⅓ |
| 180 | 109. | 19.62 | 3.11 | 707 | .458 | 432 | 83⅓ |
| 190 | 107.1 | 20.35 | 4.80 | 707 | .475 | 418 | 83⅓ |
| 200 | 105.3 | 21.06 | 6.40 | 707 | .491 | 403 | 83⅓ |
| 210 | 100. | 21.00 | 9. | 691 | .500 | 394 | 83⅓ |
| 220 | 95.2 | 20.95 | 13. | 688 | .506 | 394 | 83⅓ |
| 230 | 88.2 | 20.29 | 15. | 659 | .507 | 390 | 83⅓ |

Belt still on pulley, but power exhausted. Maximum at 200 lbs. load.

WOODEN PULLEYS.

| Load on Brake, lbs. | R. P. M. | H. P. | Slip. | Ft. Belt per min. | Coeff. Friction. | Ft. Belt per H. P. per in. | Strain per inch in lbs. |
|---|---|---|---|---|---|---|---|
| 120 | 120. | 14.40 | 0 | 754 | .315 | 628 | 83⅓ |
| 130 | 120. | 15.54 | 0 | 746 | .342 | 580 | 83⅓ |
| 140 | 118.8 | 16.62 | 0 | 746 | .368 | 538 | 83⅓ |
| 150 | 117.6 | 17.64 | 0 | 739 | .394 | 503 | 83⅓ |
| 160 | 116.5 | 18.64 | 0 | 732 | .420 | 471 | 83⅓ |
| 170 | 115.4 | 19.55 | 0 | 725 | .444 | 444 | 83⅓ |
| 180 | 115.4 | 20.70 | 0 | 725 | .470 | 420 | 83⅓ |
| 190 | 114.3 | 21.70 | 0 | 718 | .499 | 397 | 83⅓ |
| 200 | 113.2 | 22.64 | 0 | 711 | .525 | 377 | 83⅓ |
| 210 | 113.2 | 23.77 | 0 | 711 | .557 | 359 | 83⅓ |
| 220 | 112.1 | 24.66 | 0 | 704 | .579 | 342 | 83⅓ |
| 230 | 112.1 | 25.78 | 0 | 704 | .605 | 328 | 83⅓ |
| 240 | 111. | 26.64 | 0 | 697 | .634 | 314 | 83⅓ |
| 250 | 111. | 27.75 | 0 | 697 | .660 | 301 | 83⅓ |
| 260 | 107.2 | 27.87 | 0 | 673 | .684 | 290 | 83⅓ |
| 270 | | | | | | | |

The next tests were of a "cotton-leather belt," so called, which was first cut 31 feet 2 inches long and weighed 37¼ pounds. I will not quote the trials of this, under a light strain, but proceed at once to that of 83 1-3 pounds per inch, in order to get which we had to cut out the length of 3¼ inches. Table II gives the results of the tests under those conditions on both iron and wooden pulleys, the brake load of 270 pounds "stalled" the engine, without any apparent slip of belt, and it was decided to reduce the width of the belt and try further. As the lace holes happened to be punched we could not well cut to even inches, but took off 3½ inches, making the belt 8½ inches wide, relaced it and tested again. This gave the initial strain of 117.6 pounds per inch, which gave on wooden pulleys:

TABLE III.

WOODEN PULLEYS.

| Lbs. on Brake. | R. P. M. | H. P. | Slip. | Ft. Belt per min. | Coeff. Friction. | Ft. Belt per H. P. per in. | Initial Strain, lbs. |
|---|---|---|---|---|---|---|---|
| 130 | 120. | 15.6 | 0 | 754 | .341 | 430 | 117.6 |
| 140 | 120. | 16.8 | 0 | 754 | .357 | 382 | 117.6 |
| 150 | 117.6 | 17.64 | 0 | 739 | .394 | 366 | 117.6 |
| 160 | 116.5 | 18.64 | 0 | 732 | .420 | 333 | 117.6 |
| 170 | 116.5 | 19.72 | 0 | 734 | .444 | 316 | 117.6 |
| 180 | 115.4 | 20.77 | 0 | 725 | .472 | 297 | 117.6 |
| 190 | 114.3 | 21.71 | 0 | 718 | .500 | 281 | 117.6 |
| 200 | 113.2 | 22.64 | 0 | 711 | .525 | 267 | 117.6 |
| 210 | 113.2 | 23.77 | 0 | 711 | .551 | 254 | 117.6 |
| 220 | 111. | 24.42 | 1.08 | 705 | .579 | 245 | 117.6 |
| 230 | 111. | 25.53 | 1.08 | 705 | .600 | 234 | 117.6 |
| 240 | 105.3 | 25.27 | 0.95 | 668 | .624 | 222 | 117.6 |
| 250 | Belt | slipped | off driver. | Engine | slowed | down. | |

PAPER PULLEYS.

| Lbs. on Brake. | R. P. M. | H. P | Slip. | Ft. Belt per min | Coeff. Friction. | Ft. Belt per H. P. per in. | Initial Strain. |
|---|---|---|---|---|---|---|---|
| 130 | 120. | 15.64 | 0 | 754 | .342 | 414 | 117.6 |
| 140 | 120. | 16.80 | 0 | 754 | .368 | 382 | 117.6 |
| 150 | 118.8 | 17.82 | 0 | 746 | .394 | 356 | 117.6 |
| 160 | 118.8 | 19. | 0 | 746 | .423 | 333 | 117.6 |
| 170 | 117.6 | 20. | 0 | 739 | .446 | 316 | 117.6 |
| 180 | 116.3 | 20.97 | 0 | 732 | .472 | 297 | 117.6 |
| 190 | 115.9 | 21.03 | 0 | 725 | .500 | 283 | 117.6 |
| 200 | 114.3 | 22.86 | 0 | 718 | .523 | 267 | 117.6 |
| 210 | 113.1 | 23.73 | 0 | 711 | .550 | 254 | 117.6 |
| 220 | 111. | 24.42 | 0 | 697 | .578 | 242 | 117.6 |
| 230 | 110. | 25.30 | 0 | 691 | .602 | 232 | 117.6 |
| 240 | 101.4 | 24.40 | 6.30 | 675 | .595 | 237 | 117.6 |
| 250 | | | | | | | |

Engine slowed and belt slipped off driver. Weighed again and strain found the same = 117 pounds per inch.

It will be seen by these figures that the 8½-inch belt developed nearly as much power as it did at 12 inches, and was entirely uninjured by the increased strain. It simply exhausted the engine, and showed no signs of wear or stretch. This shows a remarkable uniformity of friction between the wooden and paper pulleys. It must also be remembered that with this belt the soft side of the leather was in contact with the pulley.

We next took the new leather belt, which, it will be remembered, was quite raw and stiff, and cut that down to the same width and tried it, grain side to pulley, under the same strain of 117.6 pounds. The results were:

TABLE IV.

WOODEN PULLEYS.

| Lbs. on Scale. | R. P. M. | H. P. | Slip, per cent. | Ft. per min. | Coeff Friction. | Ft. per H. P. per in. | Initial Strain. |
|---|---|---|---|---|---|---|---|
| 80 | 114.3 | 9.14 | 0 | 718 | .210 | 667 | 117.6 |
| 90 | 113.2 | 10.19 | 0 | 711 | .237 | 593 | 117.6 |
| 100 | 109. | 10.90 | 1.09 | 692 | .260 | 514 | 117.6 |
| 110 | 107. | 11.70 | 3.77 | 699 | .280 | 503 | 117.6 |
| 120 | Slipped. | | | | | | |

PAPER PULLEYS.

| Lbs. on Scale. | R. P. M. | H. P. | Slip, per cent. | Ft. per min. | Coeff. Friction. | Ft. per min. | Initial Strain. |
|---|---|---|---|---|---|---|---|
| 80 | 117.6 | 9.41 | 0 | 736 | .210 | 667 | 117.6 |
| 90 | 116.5 | 10.48 | 0 | 732 | .236 | 593 | 117.6 |
| 100 | 115.4 | 11.54 | 0 | 725 | .262 | 534 | 117.6 |
| 110 | 115.4 | 12.60 | 0 | 725 | .290 | 485 | 117.6 |
| 120 | 114.3 | 13.72 | 0 | 718 | .315 | 445 | 117.6 |
| 130 | 113.2 | 14.72 | 0 | 711 | .341 | 411 | 117.6 |
| 140 | 112.1 | 15.69 | 0 | 704 | .367 | 382 | 117.6 |
| 150 | 110. | 16.5 | 1.09 | 697 | .391 | 359 | 117.6 |
| 160 | 108. | 17.28 | 4. | 707 | .404 | 348 | 117.6 |
| 170 | Slipped | off pull | eys as bef | ore at red | uced spee | d. | |

In this last trial it will be seen that the paper pulley showed a decided advantage over the wooden one, but the belt had probably been softened and become flexible by the previous trials. We then took the "rawhide belt," which had shown such goods results previously and cut that down to 8½ inches and tried on wooden pulleys as follows:

TABLE V.

WOODEN PULLEYS.

| Lbs. on Brake. | R. P. M. | H. P. | Slip, per cent. | Ft. Belt per min. | Coeff Friction. | Ft. per H. P. per inch. | Initial Strain. |
|---|---|---|---|---|---|---|---|
| 80 | 120. | 9.60 | 0 | 754 | .210 | 667 | 117.6 |
| 90 | 120. | 10.80 | 0 | 754 | .240 | 635 | 117.6 |
| 100 | 117.6 | 11.76 | 0 | 739 | .268 | 534 | 117.6 |
| 110 | 115.4 | 12.69 | 0 | 725 | .289 | 485 | 117.6 |
| 120 | 115.4 | 13.75 | 0 | 725 | .312 | 448 | 117.6 |
| 130 | 114.3 | 14.86 | 0 | 718 | .342 | 401 | 117.6 |
| 140 | 114.3 | 16. | 0 | 718 | .368 | 385 | 117.6 |
| 150 | 113.2 | 16.98 | 0 | 711 | .394 | 355 | 117.6 |
| 160 | 113. | 18.08 | 0 | 710 | .420 | 333 | 117.6 |
| 170 | 111 | 18.87 | 0 | 697 | .446 | 314 | 117.6 |
| 180 | 111. | 19.08 | 0 | 697 | .476 | 297 | 117.6 |
| 190 | 111. | 21.09 | 0 | 697 | .500 | 280 | 117.6 |
| 200 | 110. | 22. | 0 | 691 | .525 | 269 | 117.6 |
| 210 | | | | | | | |

It was then tried on the paper pulleys, as follows:

| Lbs. on Brake. | R. P. M. | H. P. | Slip, per cent. | Ft. Belt per min. | Coeff. Friction. | Ft. per H. P. per in. | Initial Strain. |
|---|---|---|---|---|---|---|---|
| 90 | 122.4 | 11.02 | 0 | 769 | .358 | 592 | 77.72 |
| 100 | 121.2 | 12.12 | 0 | 761 | .398 | 503 | 77.72 |
| 110 | 120. | 13.20 | 0 | 754 | .438 | 486 | 77.72 |
| 120 | 120. | 14.40 | 0 | 754 | .477 | 445 | 77.72 |
| 130 | 118.8 | 15.44 | 0 | 746 | .517 | 411 | 77.72 |
| 140 | 117.6 | 16.46 | 0 | 739 | .557 | 382 | 77.72 |
| 150 | 115.4 | 17.31 | 1.87 | 739 | .585 | 352 | 77.72 |
| 160 | | | | | | | |

Slipped off, with slight warming. Put back and strain weighed, before unlacing. Found to have shrunk from 117.6 pounds to 77.6 per inch. The belt was probably overstrained and stretched in the last trial on the wooden pulley, when it showed one horse-power per inch for 269 feet speed per minute. It will be seen that the paper pulley gave rather better results than the wooden one until the belt flew off.

It should be noticed that all the pulleys were "crowned" ⅛ inch to the 12-inch width. This completes the record of comparative tests of pulleys, but I have others bearing on another question, viz., the amount of slip, caused by entrained air, which may be interesting, although not as yet very conclusive.

My attention was drawn to the following subject more than fifty years ago in starting up a large woolen mill, in the construction of which I had been engaged.

A large vertical belt, about 36 inches wide, rose from the basement to the sixth story, where it carried about 240 H.P. and had a heavy "binder" resting on it to take up slack and keep it in close contact with the driven pulley, which was 5 or 6 feet in diameter.

The explosion of the entrained air at this pulley was something like that of a bunch of Chinese firecrackers, and the electricity generated was such that the overseer of the room placed a wire in contact with the belt and amused himself by lighting up his nearest gas burner. Taking the wire in one hand and holding a finger of the other to the burner it gave a slight but not unpleasant shock.

Experiments have been made to get rid of this accumulation of air, by perforating either the belts or the pulleys, and I have made some trials of perforated belts. In the apparatus used the shafts were on the same level, so that the belts were horizontal, and were 12 feet from center to center.

The driving pulley was 30 inches in diameter, and the driven one 12 inches. The belts were cut 29 feet 3 inches long, and were 6 inches wide, and the driven pulley was mounted on a frame sliding on "ways," which could be drawn up to give the desired tension. The weights in scale were applied to a lever, which was the radius of a 10-foot circle. The "slip" as given is doubtful, as the speed of the "driver" was determined by an assistant, with a common speed counter, and the speed was very irregular, owing to deficiency of engine power and the throwing on and off of other machinery.

In previous trials an automatic counter was used, consisting of a dial and index attached to the driving shaft, which could be read easily at the strokes of a bell, which was rung every 100 revolutions of the driven shaft, but this could not be applied in this case. The first belt quoted was a light double one, weighing 21.5 pounds, on iron pulleys, with these results; belt unperforated:

Mr. George L. Crepon, of Philadelphia, puts out a perforated pulley which seems to be admirably adapted for this purpose. Thorough trials will be made of this, a description of which I will give later.

TABLE VI.

| Lbs. on Scale. | R. P. M., Driven Pulley. | H. P. | Slip, per cent. | Ft. Belt per min. | Coeff. Friction. | Ft. per 1 H. P. per in. | Initial Strain, lbs. |
|---|---|---|---|---|---|---|---|
| 25 | 690 | 17.25 | 2. | 2210 | .363 | 769 | 58.33 |
| 30 | 612 | 18.36 | 13. | 2210 | .392 | 724 | 58.33 |
| 30 | 720 | 24.9 | 9.3 | 2396 | .411 | 600 | 66.66 |
| 35 | 741 | 25.9 | 7.8 | 2527 | .376 | 585 | 75. |
| 4 | 674 | 26.96 | 5.6 | 2245 | .306 | 500 | 82.⅓ |

SAME BELT, "PERFORATED" OR "SLOTTED."

| Lbs. on Scale. | R. P. M., Driven Pulley. | H. P. | Slip, per cent. | Ft. Belt. per min. | Coeff. Friction. | Ft. per 1 H. P. per in. | Initial Strain, lbs. |
|---|---|---|---|---|---|---|---|
| 25 | 800 | 20. | 3.8 | 2613 | .444 | 784 | 52. |
| 30 | 706 | 21.18 | 5.1 | 2339 | [illegible] | 663 | 62.⅓ |
| 35 | 706 | 24.71 | 3.2 | 2292 | .395 | 556 | 75. |
| 40 | 700 | 28.1 | 4. | 2292 | .463 | 500 | 75. |

DRESSED BELT, WITH PAGE CO. DRESSING.

| Lbs. on Scale. | R. P. M., Driven Pulley. | H. P. | Slip, per cent. | Ft. Belt, per min. | Coeff. Friction. | Ft. per 1 H. P. per in. | Initial Strain, Lbs. |
|---|---|---|---|---|---|---|---|
| 35 | 822 | 28.77 | 4.4 | 2700 | .586 | 563 | 50. |
| 40 | 770 | 30.8 | 2. | 2475 | .411 | 482 | 83.⅓ |
| 45 | 750 | 33.75 | 4. | 2440 | .455 | 425 | 83.⅓ |

These trials do not show any very great advantage in the perforations, but the speed was not high enough to entrain a great quantity of air, and was so irregular as to make observations difficult.

At the time I was making the previous trials, some years ago, there was a great craze about an abortion known as a link-belt, and the belt-makers were "tumbling over each other" in their eagerness to devise some new form in which they might utilize their scrap leather in this way. After trying a 12-inch belt of this kind I found it so heavy, 196 pounds, that it nearly shook down the counter-shaft, and after shoring and bracing that up it slipped off and caught against a hanger.

* * *

## EFFECT OF SOAP IN HARDENING WATER.

In reply to the question, "Why is it not possible to temper steel in soapy water? R. A. McDonald, of the Crescent Steel Co., gives the following explanation in the last number of "Sparks from the Crescent Anvil":

Without going into the chemistry of the subject, the simple answer is: Soapy water is a non-hardener because it does not rapidly abstract or conduct heat from the object to be hardened, and, secondly, it produces a heavy scale which sticks tightly to the surface, the scale being oxide of iron, and this formation is the main preventive.

An interesting experiment to determine the action of soapy water is to prepare two samples of steel of the same area, say one inch round, and turn them to seven-eighths round; also provide two buckets of water, one fresh and the other soapy, say about five per cent. soap.

Then heat both samples up to the same degree of heat as nearly as possible, and plunge one into the fresh water and the other into the soapy water at the same time.

As soon as the red disappears from the one in the fresh water withdraw both from their respective baths and note the appearance of the two pieces. The one that has been in the soapy bath will brighten up and show a reddish heat, while the sample that was chilled in the fresh water will come out black, showing, as far as the experiment goes, that one bath will absorb the heat from the steel much faster than the other, and that consequently one piece becomes hard while the other is left soft.

To carry the experiment farther, reheat the two samples up to the proper hardening heat and then quench them the same as before, allowing both pieces to remain in their respective baths until cold. Examine the surface of each piece when withdrawn and quite a contrast will be observed. The fresh water hardening will show very little, if any, scale, and what there is will be quite thin and loose. The sample from the soapy water will show a heavier scale, and usually it will stick tight to the steel—an oxide of iron has formed on its surface.

## CHEMISTRY IN MACHINE SHOP PRACTICE.

### A LIST OF CHEMICALS AND THEIR USES IN PRACTICAL WORK.

WARREN E. WILLIS.

Chemistry is that branch of Natural Science that considers the properties and composition of material substances. The name itself is supposed to be of Arabic origin, as are many of the names and terms used therein, as alkali, alcohol, borax, elixir, etc. It is not a science of recent times, as is often considered, but it, or its antetype, Alchemy, dates back to the earliest records of the ancients.

Many chemical facts were known to them, as is evidenced by the smelting of ores and working of metals without which but few of their works of art, still existant, could have been made. They made articles of glass and understood the coloring of it; the Damascus blade, the Royal Purple dye, the articles of bronze as found in recent excavations, the Chinese vases, centuries old, and Egyptian monuments and mummies, all bear silent witness to their skill in these things of long ago. Yet such science as theirs was probably not the result of patient experimental investigation, but rather isolated facts, the result of mere accident, handed down from one generation to another.

The underlying basis was not understood, as can be clearly seen in the fact that for centuries vain attempts were made to change the so-called baser metals into those esteemed as noble: as iron and lead into silver and gold, or to find an elixir capable of prolonging human life and thus pervert the laws of nature; but the philosopher's stone is not to be found, either to permute metals or prolong life.

The political conditions of France towards the close of the last century exerted a strong influence upon the progress of chemistry, especially in its application to the arts and sciences and its diffusion as a branch of popular knowledge. For when that country, accustomed as it had been to purchasing its most important munitions of war, was cut off from outside communication and was compelled to defend itself from all Europe, scientific men, especially chemists, were called upon to produce means for creating the material of war on which the life of the nation depended.

When order was again restored new institutions were formed for instruction, in which the study of mathematics and physical science were made especially prominent.

The influence which these schools have had in diffusing chemical knowledge has been highly important; since the latter has become a matter of popular education, the methods of teaching it have been made subjects of special study and have been greatly improved.

The immense influence which chemistry now exerts upon all arts and manufactures is characteristic not only of the science itself, but of civilization and the intelligence of the nineteenth century. The reason why bread rises, electric bells ring, iron rusts, ice forms and thousands of other every-day occurrences are surely interesting.

### A List of Chemicals.

It is believed that the majority of mechanics, without being specially informed on the subject, divide all chemical substances, either fluid or solid, into two classes: rust producers, represented by corrosives, such as most acids, on the one hand, and on the other substances which neutralize such action, as alkalis of various kinds.

For ordinary practical purposes this is mainly correct, but far from specific; a wider and more definite knowledge of chemicals and chemical combinations, it is believed, would tend to benefit the mechanic, be he employer or employee.

The following list of chemicals and other substances, together with a brief statement of their main shop uses, and sources from which they are derived, may possibly be of interest:

ALCOHOL is made from a variety of vegetable growths, especially grains; the crushed and moist particles of the substance is termed a mash and permitted to ferment, and from that stage the alcohol is withdrawn by distillation.

It is a strong dissolvent, readily cutting most oils and gums, thus finding extensive use in lacquers and varnishes and for cleaning purposes; it is highly volatile, and should be well stoppered; it burns with a clear, strong flame, without smoke, producing a large amount of heat, due to the carbon it contains, and is used largely in blow-pipe lamps. Possessing, as it does, antiseptic properties, cut and bruised parts of the human body may be cleansed and stimulated by external applications.

Wood alcohol is a by-product of charcoal, making destructive distillation; its comparative low cost causes it to be used for many purposes where its disagreeable odor is not objectionable; it has all the properties of grain alcohol and is nearly as colorless.

AQUA AMMONIA is a colorless liquid, possessing a characteristic and strongly pungent smell; it is a powerful alkali, useful in neutralizing acids and acid strains or burns, and restoring to fabrics their original color; it has strong cleansing properties, rendering it of great domestic utility; at the same time being used extensively in the manufacture of artificial ice.

It is produced on a large scale by treating the ammonical liquor of the gas works with slaked lime and heating the mixture, the resulting gas being dissolved in water, which at 60° Fahrenheit will absorb about 750 volumes of the gas; in this state it is the aqua ammonia caustici, spirits of hartshorn or liquid ammonia of commerce.

### Acids.

Acid, Acetic, is a vegetable acid, the foundation of most of the domestic "sours," as vinegar, wines, etc., and cooling (?) summer beverages. Acid, Boracic or Boric, is obtained from the collected and concentrated gases and fumes from volcanic springs in Tuscany. It is used in making Borax, and is also employed in increasing the whiteness of silver alloys and in decomposing the sub-salts deposited in electro-baths containing potassium cyanide.

Acid, Hydrochloric or Muriatic, is made by heating together, in an iron vessel, common salt (sodium) and sulphuric acid; the acid, which is a gas, is given off and dissolved in water, which will absorb 460 volumes of the gas. It is used on a large scale as a by-product, in the manufacture of soda, and finds extensive industrial applications, such as the pickling of iron and brass castings.

Acid, Nitric, usually made from powdered nitre and sulphuric acid, is a powerful caustic, unstable and subject to spontaneous explosion, being used in combination with muriatic acid. It is used largely in the manufacture of celluloid, cellulose, gun cotton and several high explosives.

It is very powerful in oxidizing or dissolving all metals except gold and platinum; nearly all metalloids, like sulphur, phosphorus and carbon are converted by it into their corresponding acids; it readily destroys all organic substances.

A mixture of one volume of nitric acid and three volumes of hydrochloric acid is known as aqua regia, and is able to dissolve both gold and platinum, which neither acid will do alone.

Acid, Oxalic, is found universally throughout the vegetable kingdom, oxalates being in the juices of all plants at some time during their growth, notwithstanding that it is a most powerful poison; it is made commercially from starch or sugar, heated with nitric acid, and is used in removing ink, iron rust and other stains from the hands or fabrics; also in purifying and bleaching shellac and similar gums.

Acid, Picric, while a poison if taken into the system, has the remarkable property of soothing and healing burns when applied externally, and should be in every foundry and shop where such accidents are likely to occur; it is of a bright yellow color, has a bitter taste, with no smell. Made from nitric acid and vegetable substances.

Acid, Sulphuric, when concentrated, is a thick oily fluid; nearly all metals are attacked by it; it is a very strong acid, and when heated expels most other acids from their salts. It unites with water with the evolution of heat; this explains the charring of wood, from which it withdraws the oxygen and hydrogen in order to form water. It is found useful for drying gases, and is used largely in foundries, diluted with water, to loosen the scale and sand.

Large quantities are prepared from rock sulphur (brimstone) and lime roasted together in retorts, the escaping vapor forming the article of commerce.

### Miscellaneous Chemicals.

BENZINE is a highly volatile product of petroleum or mineral (rock) oil, and is made use of in cleansing fine machinery, etc.;

it possesses the property of rapidly dissolving grease, paint, etc., and bringing the metal surfaces to their original appearance.

Borax, while a natural deposit, occurring in several places on both continents, is prepared also artificially from boric acid and soda, and is used extensively as a solvent for metallic oxides and as a flux in welding and brazing operations; also in glass manufacture and in the preparation of glazes for pottery.

It has strong cleansing properties, adapting it to many domestic purposes, and may be used as an antiseptic for the preservation of food and in medicine.

Carborundum is an artificial product of the electric furnace acting upon clay; the grains produced are next in hardness to the diamond, being superior to emery; it is used in the same manner as emery, which it would largely supersede if an efficient bond be found for it.

Corundum is a mineral—alumina—remarkably hard, a species of gem stone, of which emery is a variety; it is used as an abrasive in polishing and grinding.

Crocus is but the finely divided particles of oxide of iron-red rust; used as an abrasive for polishing and sharpening.

Cupric Sulphate, Sulphate of Copper, Blue Vitriol, and Blue Stone are but the several names of the same thing; it is obtained by roasting the copper sulphite ores (copper pyrites); the result, dissolved in water, produces the semi-transparent blue crystals of commerce.

The sources of supply are Russia and the Lake Superior region of the United States; it is used in dyeing, electroplating, plain coppering—the machinists' well-known solution—and prevention of decomposition of organic substances.

Chalk is a calcareous deposit of infinitesimally small shells, of which England is the chief source of supply, nearly the entire island being underlaid with it. When finely ground it becomes Whiting.

Emery is obtained principally from the islands of the Grecian archipelago; its hardness depends upon the amount of iron and silica in its composition.

It is of the same mineral species as many of the Oriental precious stones, such as rubies and sapphire, but of a dense, opaque, dull bluish or brownish black color.

Mercury, a true metal, obtained from the quicksilver mines of Russia, practically a fluid, has a strong affinity for other metals, forming with them what is called an "amalgam"; it is used on electric-battery plates, electro-plating, for silvering mirrors, etc.

Potassium Cyanide, a powerful poison, having an odor similar to prussic acid, is a white, easily fusible substance, crystallizing in cubes, which easily deliques in the air; it is the indirect product of finely divided iron and animal matter heated to redness, usually obtained during the manufacture of potassium prussiate.

By fusing, potassium cyanide reduces many metallic oxides and hence is employed in reduction processes; it is also used in photography, in glavanic plating, and as an agent in hardening, leaving the surface of the metal in a clean, white condition, the results being the most satisfactory of any of the substances usually employed.

Prussiate of Potash, or, more properly, the Ferrocyanide, being somewhat cheaper, is frequently used in place of the above, in hardening operations, the properties being nearly the same, but the work being discolored and uncleanly. It is prepared commercially by igniting carbonized nitrogenous animal matter (blood, horns, hoofs, leather, offal, etc.) with potash and iron.

Common Salt, or Chloride of Sodium, is gained from the sea and natural deposits in many countries; its use for mechanical purposes is principally in hardening, a solution of brine having a greater affinity for iron than fresh water, causing it to take hold quicker on the hot metal and without forming air bubbles, thus causing soft spots; the work should be well washed in fresh water, otherwise the salt is likely to cause the metal to "oit" and rust.

Sal Ammoniac is the product of the ammoniacal liquor—a by-product of gas manufacture, treated with hydrochloric acid, and is used in welding, brazing, soldering and making "rust joints."

Soda—Sal Soda—is made from ashes, but more largely from the decomposition of common salt; used quite extensively dissolved in water—preferably kept hot—to remove grease, oil and dirt, and being capable of neutralizing acids acts as a rust preventative. A saturated solution is also used in machining wrought iron, producing the so-called water-polishing effect. By its combination with and affinity for grease, it readily froms a soap and is indispensable where cleanliness is desired.

* * *

## A THREE-CYLINDERED SHOP MOTOR.

The somewhat novel form of motor shown in the accompanying engraving, Fig. 1, is one that was built a few years ago in the Fallbrook shops at Corning, N. Y., under the supervision of Mr. C. R. Williams, who at that time was the general foreman of the engine repair work. This engine was designed and built to meet the demand for a portable form of motor that could be easily transported and which could be set up with a minimum of labor and easily made ready for the operation of such tools as desired. The selection of the tripod form of base probably secures the greatest stability with the least weight, and if the work required the addition of more weight it was secured by hanging peculiarly shaped castings on the legs, the supporting pins being shown in the cut.

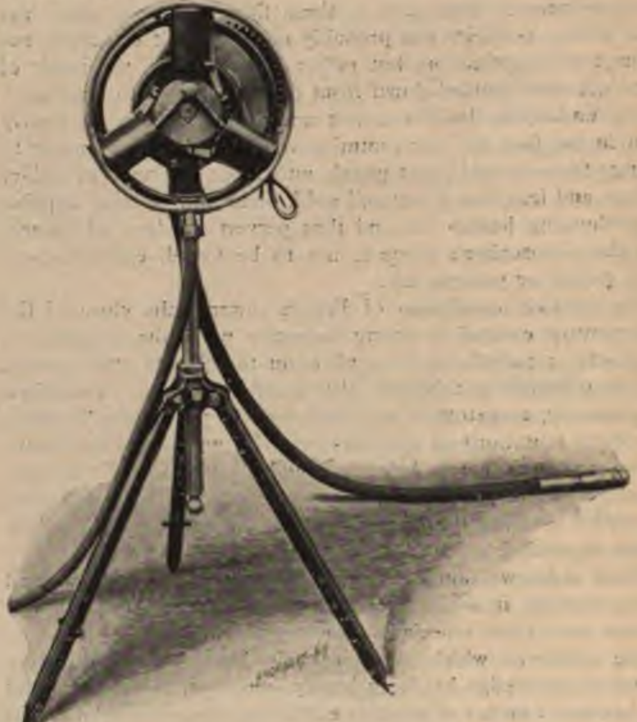


FIG. 1. NOVEL SHOP MOTOR.

The design of the cylinders and valve-gear is considerably out of the ordinary, and, as will be noted, consists of three cylinders with trunk pistons and piston valves, which have a movement at right angles to the axis of the cylinders. The valves are operated by a single cam through the three levers having rollers at their inner ends. The connecting-rods are all connected to the same crank-pin, so, of course, the single cam will cause the different events necessary for the proper action of the valves to come in their order.

The motor is designed for the use of compressed air and the supply is taken at the bottom of the pipe-ring shown, which distributes it to the three cylinders. The exhaust is allowed to escape at the ends of each of the piston valves, no exhaust-pipe being needed when the medium used is compressed air.

For ordinary work the power is taken directly from the crank-shaft, but if a greater reduction and more power be needed it is secured by throwing in a back-gear, which shows rather indistinctly at the back.

The motor is shown with a Stow flexible shaft attached, which makes a convenient arrangement for drilling or, when attached to the device shown in Fig. 2, a very powerful reaming combination. The idea of the reaming device is clearly conveyed by the sectional view, which shows the ball-bearing worm and the worm-wheel, which has a socket, I, for the square of the reamer. The device being intended to lessen the labor incident to the erection of locomotive work on the pits was arranged to drive the ordinary taper reamers having square shanks which are generally used on hand work. A is the worm, B the worm-gear, E is a hardened thrust collar, and D is an adjusting screw for the thrust.

Another use which is more suited to the capacity of this motor is the driving of the valve-facing machine, a sort of portable rotary planer that is much used in locomotive work for repairing the abrasive action of the slide valves on their seats that too often run with no other lubricant than that furnished by the steam. The work required of these portable planers in some railroad shops, on account of a mistaken policy which enforces the niggardly use of valve oil, would astonish a person who was only familiar with the conditions under which the ordinary stationary engine runs. A valve-seat one inch and a quarter high would ordinarily wear a century in a stationary engine, but for a locomotive it is barely sufficient, in most instances, to last five or six years. In consequence of this a small portable motor for this work serves a very useful purpose in most railroad shops.

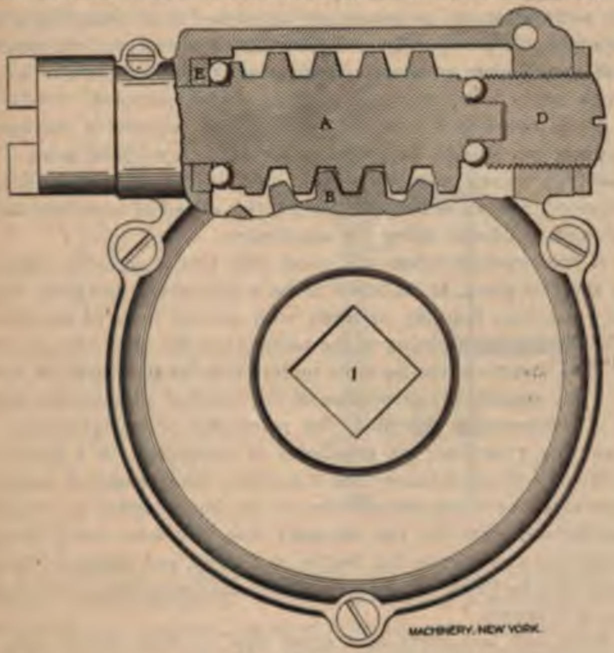


FIG. 2.

* * *

## A REVOLVING TOOL-POST.

W. A. Bright.

The accompanying half-tone, Fig. 1, and sketch, Fig. 2, illustrate a form of revolving tool-post which is designed to be used on a lathe having a plain slide-rest which takes the ordinary form of round tool-post with a ring and wedge. The design of this fixture is such that it can be applied or removed very quickly, and, as may be seen, will accommodate four tools.

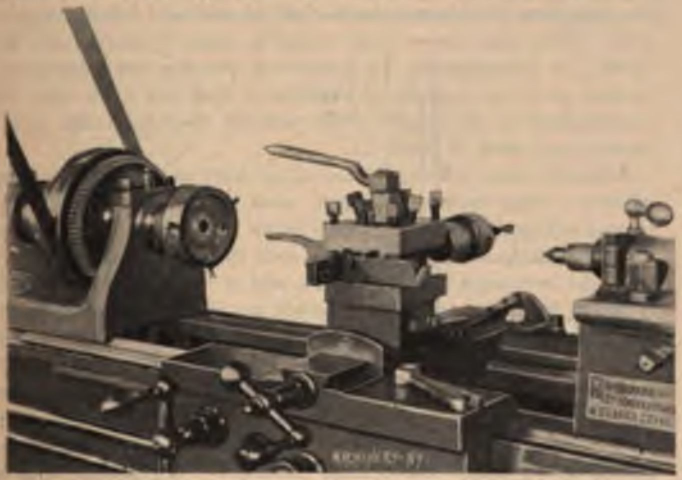


FIG. 1.

In its construction a piece of steel was first planed to fit the T slot in the rest, leaving the piece high enough to turn a boss on the top as large as the width of the slot would allow. A block was cast with a groove on the outside surface ¾" deep and ⅜" wider than the lathe steel. A set-screw was put in each corner, and one in the middle of each side, as shown in Fig. 2. The tools could then be held as shown in the photograph or as arranged in the sketch, Fig. 2. A stop is located at the back of the post, which can be adjusted so that a drill or reamer will coincide with the axis of the spindle when the post is against the stop. To accommodate drills, reamers or turret tools, two holes were bored through the block as close together as the binding bolt would allow. The post revolves to the left and has a stop in the under side to locate it in the correct position for each tool.

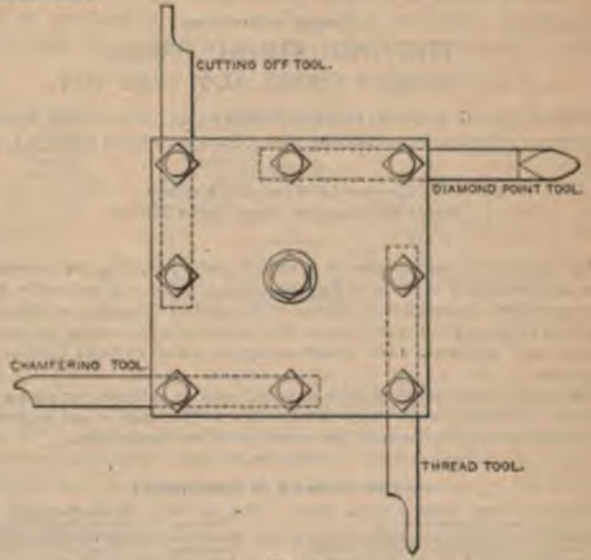


FIG. 2.

On a job that requires to be bored and faced the tools are set as shown in the photograph, Fig. 1, but where the work is all turning, such as making a lot of special screws from the bar, the tools should be set as shown in Fig. 2.

The device shown in Fig. 3 is a block for holding boring tools made of octagon steel, and is made as long as the width of the rest. Two binding screws are provided and two grooves—one for ¾" steel and the other for ⅝" steel. The boring tools are made to cut on the center line, so it is never necessary to adjust them up or down. By this means I save forging and do not have to use a long tool on a short hole, but can always have the tool the right length of the depth of the hole. Should any of the readers of MACHINERY wish to make a revolving post similar to the one described I will tell them on request how to make the stop which is not shown in the photograph.

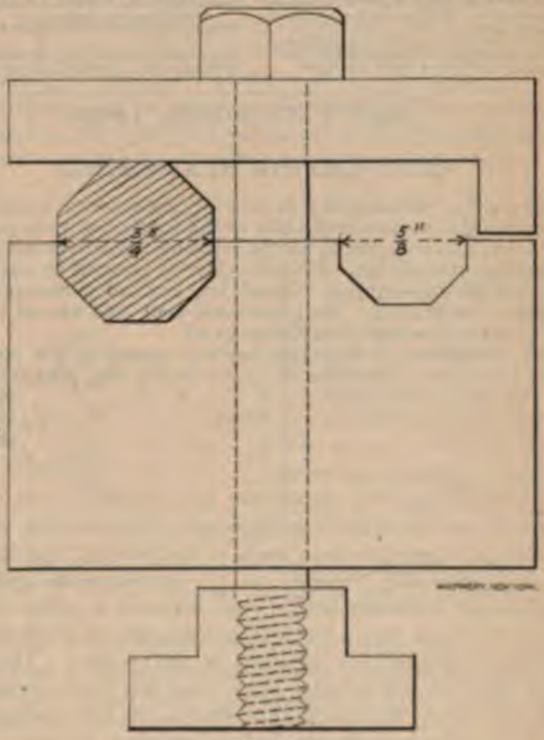


FIG. 3.

About new lathes, we cannot all get them because we are not able, and then, again, because the "Old Man" won't. I always look at the cuts of the new lathes advertised in MACHINERY and sometimes send for catalogues. I look at the pictures and wish that I was in the "Old Man's" place long enough to order one and to scrap the old one.

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## SEPTEMBER, 1899.

## CIRCULATION STATEMENT.

The regular edition of Machinery for September is 17,150 copies, American Machinery is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. No papers are sent free except to advertisers, exchanges and circulation agents

The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

| | |
|---|---|
| The Iron Age, about | 7,000 |
| The American Machinist, about | 12,000 |
| Machinery | 18,000 |

Five years ago this month the first number of Machinery appeared, and its readers will probably acknowledge that considerable progress has been made in the interval. An individual who is continually boasting of his achievements and giving other people unsought advice, soon becomes a public nuisance; and as the same rule applies to newspapers we shall keep well outside the chance for criticism in this respect. The figures at the head of this column show what has been accomplished in one direction; but Machinery itself is the best evidence, after all. The readers are the real judges, and their decision is shown by the steadily increasing circulation.

* * *

## THE NEW SCHOOL YEAR.

This month thousands of young men will begin careers as students in the various schools and colleges Of these thousands many hundreds will elect courses in engineering, and of them a considerable number will take up the study of mechanical engineering.

Most boys, at one time or another, display a genius for mechanics. They like to watch machinery in operation, are clever with tools, and often originate neat devices; people tell them that they are ingenious and that in consequence they ought to study mechanical engineering. We mention this fact because ingenuity is the last thing that should influence a young man in deciding to take a course in mechanical engineering. All boys are more or less ingenious; it is a common trait in youth, but unless it is coupled with certain individual characteristics that are of more importance, it will be of very little assistance in helping to become a mechanical engineer.

Another mistaken impression that seems to be quite prevalent is that whatever pertains to machinery or mechanics is of a superficial character, requiring no deep study, and is easily mastered by anyone. The list of worthless inventions patented by men who imagine they have grasped this or that principle in mechanics without study or investigation, shows how many have held this view. Few appreciate the depth and breadth of the mechanical engineering profession and what is required in the way of work, study and experience to attain distinction in it.

A student who is commencing a college course in mechanical engineering should be prepared for hard, persistent work. The ability to work constantly and hard is the main qualification required, and we unhesitatingly put this ahead of inventive faculty or even a natural liking for machinery.

A brief consideration will show why this is so. An engineer, in the first place, is supposed to be a competent designer, and to be somewhat familiar, at least, with several lines of machinery. The mere proportioning of the parts is not the only consideration. If it is a steam engine, he must understand the principles of steam; if a gas engine, the principles of the internal combustion motor; if a refrigerating machine, the principles of refrigeration; if a pump or a turbine, the principles of hydraulics; if a boiler, the principles of combustion; and if a crane, the strength of materials. Subjects like these, in addition to the fundamental principles of mechanics, form the line of study that one must carry through before he can receive his degree at college and many of the subjects will be found mathematical and uninteresting to the majority of students.

First and last there is a great deal of fault found with the technical schools because the graduates do not always take hold of practical work with the degree of success that they ought to after four years of study. If these criticisms are justified, it is probably because the professors fail to impress their students with the importance of getting into touch with actual machine construction during their course of study. To the "ability for hard work," we should add "the determination to obtain practical work" in connection with the theoretical studies that are given. Workshop practice or experience is needed by every student to complete his education. He can, if he will, obtain part of this during his vacation, and we are glad to note an increasing tendency on the part of students to do this. This experience is of immense value in designing. It gives a familiarity with machinery that can be obtained in no other way, assists one in the maintenance or operation of machinery and gives a knowledge of the precision of measurements that no physical laboratory can give. Shop experience is the stepping stone to responsible positions of management, to consulting practice and designing; in fact, to every position of importance that has to do with the construction of machinery, while without this knowledge one is barred from most of them.

Students often follow these courses with no definite aim and without a clear understanding of what they should do to make themselves competent in their chosen profession. The advice given by their instructors, while with the best of intentions, is from the instructor's point of view and is likely to be somewhat different from the advice that would be given by a person who has spent his time in every day commercial work. It is well for a student to view the problem of his lifework from all sides and we would suggest that the first thing to be done is to formulate a "plan of campaign" by obtaining the opinions of men who have been engaged in business, rather than relying entirely upon advice given under the college influence. We believe that in almost every instance such advice will substantiate what we say about the importance of supplementing the college course with practical shop experience before the student can hope to do well in his work after graduation.

* * *

The use of graphite on the threads of bolts and studs when erecting work will insure much less trouble in making repairs, as the threads will not rust and "seize."

# MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—2.

## LATHE FEED AND SCREW-CUTTING MECHANISMS.

W. H. VAN DERVOORT.

In all engine lathes the carriage is moved over the shears by means of the lead-screw or the feed-rod and their connections. The former constitutes a positive drive without possibility of slippage, while the latter is a purely friction drive. The independent feed-rod is frequently dispensed with in small lathes, and the lead-screw made to do its work. In such cases the lead-screw is splined and the feed mechanism is driven from a collar which has a feather engaging the spline and slides over the lead screw. As the feed is engaged by means of a clutch this also forms a frictional driver.

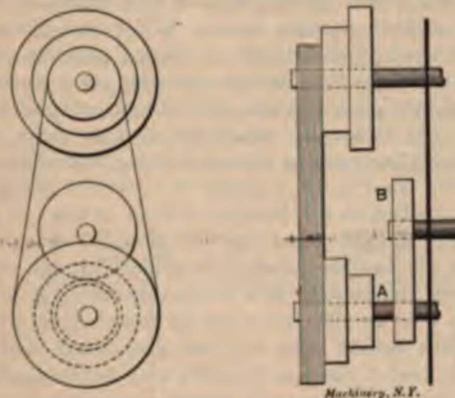


FIG 12.

The feed-rod is driven by belt and provided regularly with three changes of speed. Since it is frequently desirable to have feeds finer or coarser than these three changes can give, it is now quite common to provide either a change gear connection with the feed-rod as shown in Fig. 12 or provisions for connecting the feed-rod with the change gear mechanism of the lead-screw as shown in Fig. 13. In Fig. 12, by changing places with gears A and B, or substituting others any desired speed of feed-rod C can be obtained. In Fig. 13 when gear E is in dotted position the feed-rod is driven by belt in the usual manner. When, however, change-gear feeds are required E is in position shown and is driven by the gear D which is secured on the sleeve A and receives its motion through the change gears F and B. The clutch G, which slides over a key in the lead-screw L is disengaged from the sleeve A, thus preventing the lead-screw from turning while the feed is in operation.

As the carriage must be capable of feed in either direction, a change in direction of motion of feed mechanism must be provided for. This is usually accomplished by interposing an idle gear either in the mechanism of the apron and allowing the feed-rod to rotate constantly in one direction, or in the head-stock gearing. The latter is the more common method in as much as a change in direction of lead-screw rotation is necessary and that cannot be accomplished in the apron. In Fig. 14 is shown the arrangement of gears usually employed. Gear A is secured to the spindle of the lathe. When A gears with B, the direction of rotation of the feed cone is as shown by the arrow. B and C rotate on studs secured in a plate which turns about the axis of D. By throwing the handle H down and C into mesh with A, B becomes inoperative and the direction of rotation of D is changed The stud G also carries one of the change gears E. The diameter of gears B and C is immaterial, inasmuch as they are simply idlers between A and D, and do not affect the velocity ratio. When gear D is of the same diameter as gear A the stud and spindle have the same rate of rotation. D is, however, frequently made smaller than A, giving the stud a higher rate of rotation.

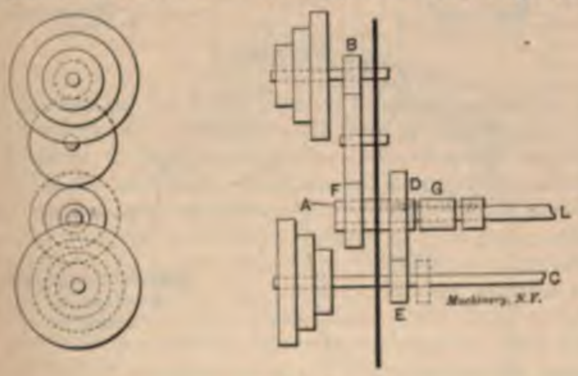


FIG. 13.

The mechanism shown in Fig. 15 is frequently employed for reversing the feed in lathes and other machine tools. The feed rod C carries two bevel pinions B and E and the clutch D. D slides over a key in C and engages either E or B, both of which run loose upon C and mesh with the bevel gear A. When D and E are locked the rotation of A will be as shown by arrow, B turning free on the shaft, and when B and D engage the direction of A is reversed.

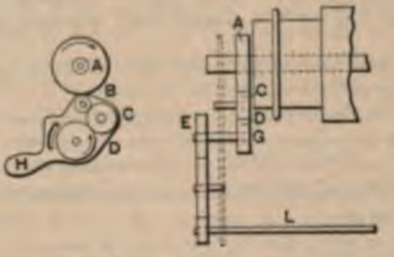


FIG. 14.

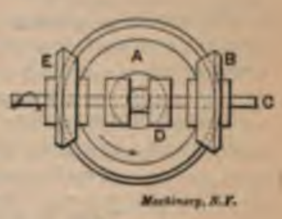


FIG. 15.

The lead-screw is one of the most important parts of the lathe, as accurate screw threads cannot be produced with an inaccurate lead screw. The builders of first class lathes use great care in the production of their screws. The lathe used for cutting them being provided with a carefully cut master screw which is used only for the cutting of lead screws, used on that lathe. The wear on this master screw is therefore very slight and as soon as the lead screw shows signs of inaccuracy the master screw is substituted and a new lead screw for the lathe cut. In this way the standard of the master screw is very closely maintained.

The lead-screw draws the carriage, the force being applied at the nut. It is, therefore, best to take hold of the carriage as close as possible to the shears and thus avoid the tendency to cramp the carriage. In the lathes manufactured by the American Tool Works Co., the lead screw is placed inside the shears in such a manner as to get the most direct pull on the carriage.

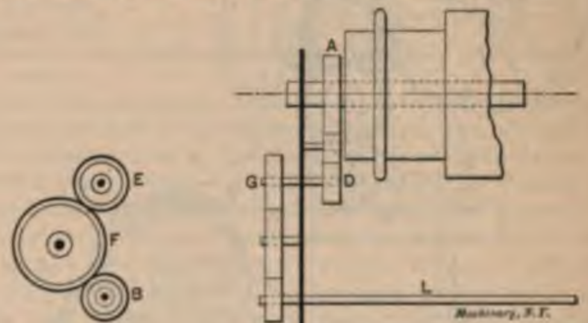


FIG. 16.

The lead screw nut is made in halves usually of brass and so mounted in the apron that it can be readily closed onto the screw.

In order to cut threads of different pitches with the same lead screw a set of change gears must be provided for the lathe, so that the advance of the screw, carriage and tool per revolution of the spindle may be exactly equal to the pitch of the thread being cut. In Fig. 16 is shown the common arrangement of change gear, and generally called a single gear. Gears A, D, and E, and the stud G, correspond to the same parts in Fig. 14. L is the lead-screw, B the gear on screw, and F an idler of any convenient size.

In cutting any number of threads per inch the point of the tool must move along the work an amount exactly equal to the pitch of the required thread for each revolution of the work, thus if the pitch of the lead-screw is 1-6 of an inch and the pitch of thread to be cut is 1-10, it is evident that the lead-screw will make less than one revolution while the work is making one. The tool has advanced 1-10 of an inch and the lead-screw must have rotated through 6-10 of one revolution. If, therefore, the work and the screw were geared together the ratio 6-10 would represent the ratio of $\frac{\text{teeth in gear on spindle.}}{\text{teeth in gear on screw.}}$ This direct ratio cannot usually be used as the gears A and D are generally of different diameters.

Assume A as having 40 teeth and D 20, then the stud G makes two revolutions for one of the spindle and work. Assume the lead-screw as having six threads per inch, to determine the number of teeth in gears E and B to cut any required number of threads per inch on the work. If six threads are required the screw must make one revolution to the work one, and since gear E rotates twice as fast as the work it should have one-half as many teeth as gear B.

The following general expressions give the ratio of teeth on stud to teeth on screw in problems similar to the above.

$$\frac{\text{Teeth in gear on stud}}{\text{Teeth in gear on screw}} = \frac{\text{spindle rotation}}{\text{stud rotation}} \times \frac{\text{threads on screw}}{\text{threads on work}}$$

With same condition as above, required to cut 12½ threads:

$$\frac{\text{Teeth in stud gear}}{\text{Teeth in screw gear}} = \frac{1}{2} \times \frac{6}{12\frac{1}{2}} = \frac{6}{25}$$

use 18 teeth in stud gear and 75 in screw-gear.

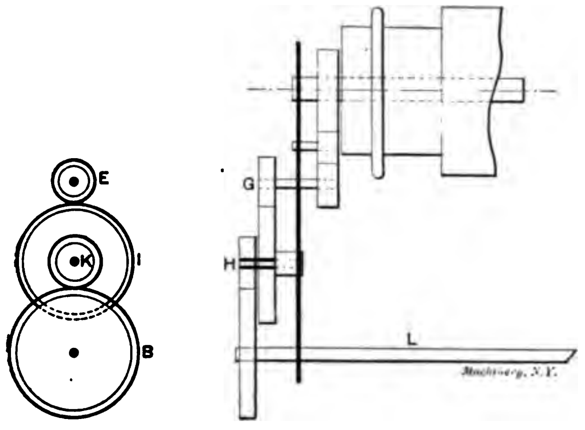


FIG. 17.

Frequently when very wide ranges of screw cutting are desired a compound system of gearing similar to that show in Fig. 17 is used, thus avoiding the use of excessively large or very small gears. In this arrangement H is the intermediate stud. I, the first gear on stud and K the second. This gives two gear reductions in place of one in the single gear shown in Fig. 16. The calculations for determining the proper number of teeth in each gear to cut any thread with the compound gearing involves one more ratio than with the single.

Assuming the velocity ratio of the stud G and the spindle the same as in Fig. 16, and the lead screw ⅛ pitch, we first determine the velocity ratio between the stud G and the lead-screw necessary in cutting the required number of threads per inch on the work. For example, to cut 100 threads per inch we would find the ratios between the stud and screw = ½ × 8-100 = 1-25. As we would not care to use a gear having fewer than fourteen teeth on the stud a gear of 350 teeth would be required on the screw if single geared. With the compound gearing, however, we are enabled to divide this ratio into factors 1-5 × 1-5 = 1-25. We could therefore use fifteen teeth on gears E and K, and 75 teeth on gears I and B. In like manner if 70 threads were to be cut ½ × 8-70 = 8-140 = 4-70, as ratios between stud and screw = 2-10 × 2-7, which would give 15 and 75 teeth for one pair and 20 and 70 teeth for the other pair.

Any pair of gears in which the teeth have the required ratio may be used, it of course being desirable to so select the change gears that the greatest possible number of required pitches may be cut with as small an assortment of change gears as possible.

In order to avoid the time lost in changing gears where large varieties of different pitch threads are to be cut, several builders have brought out lathes in which the change gears are all mounted, a change from one to the other being made by a simple lever movement. In Fig. 18 is shown this class of change gear mechanism as applied to the Hendey-Norton lathes. It will be noticed that the change gears are all mounted on the lead-screw and that the auxiliary shaft A is driven through the gear mechanism from the spindle at a fixed velocity ratio with the spindle. Gear B is an idler mounted on the shifting lever and communicates the motion from A to any gear on the lead-screw. In this manner twelve changes in pitch may be obtained without changing gears and for each change in size of gear on A twelve more pitches may be cut.

In this lathe the reversing mechanism of Fig. 15 is applied in the head as clearly shown in cut.

In a mechanism of this character the gears must be rigidly mounted and accurately cut and pitched as otherwise in such long trains the spring and back lash is excessive.

The form of thread usually used on lead screws has sides of about 15° angle, as this form allows for taking up the wear in the nut by closing it onto the screw. The U. S. S. thread is not well adapted as the steep angle of its sides forces the nut apart which is necessarily made in halves.

The lead-screw and nut should never be used for ordinary feeds as the screw would soon loose its accuracy through wear, Unfortunately for the accuracy of the screw a comparatively short portion of its length usually does most of the leading for threads cut in the lathe, and as a result that portion becomes worn and inaccurate while the balance remains in good condition.

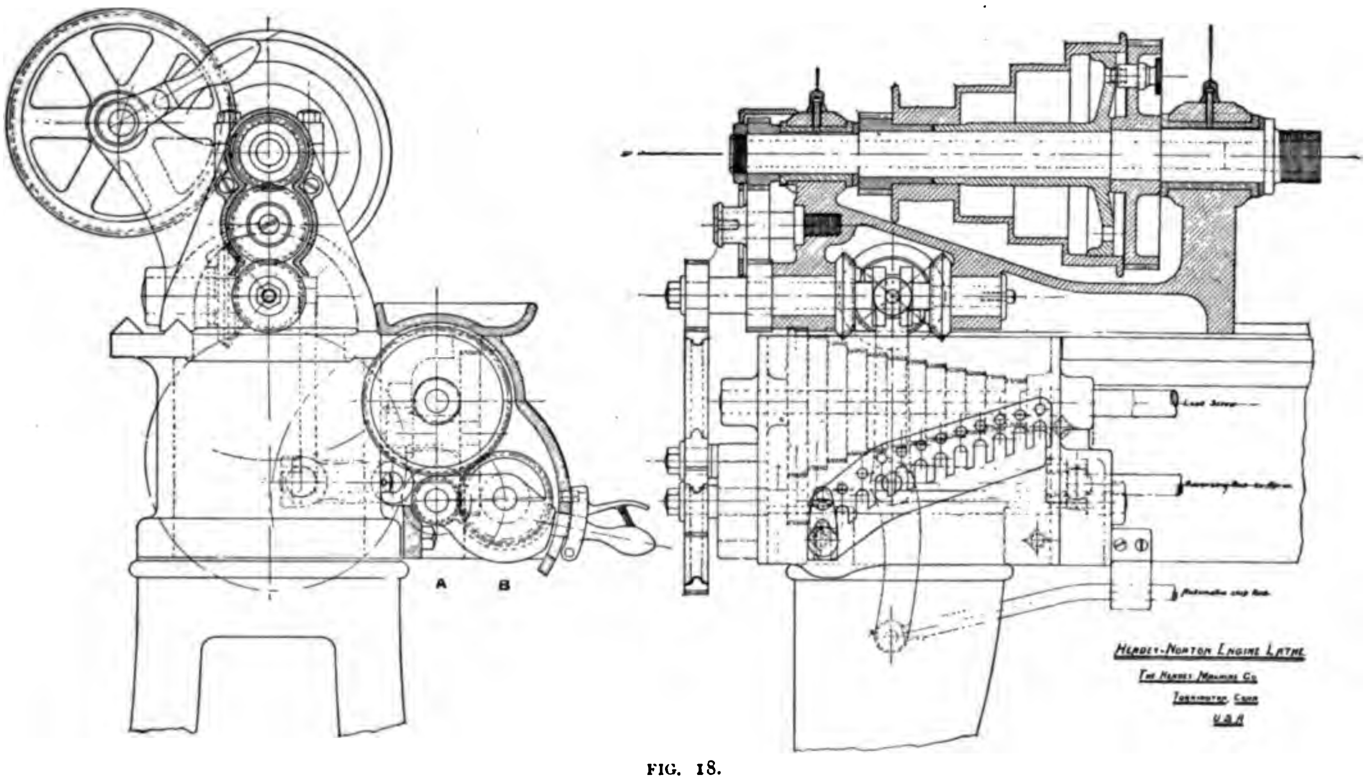
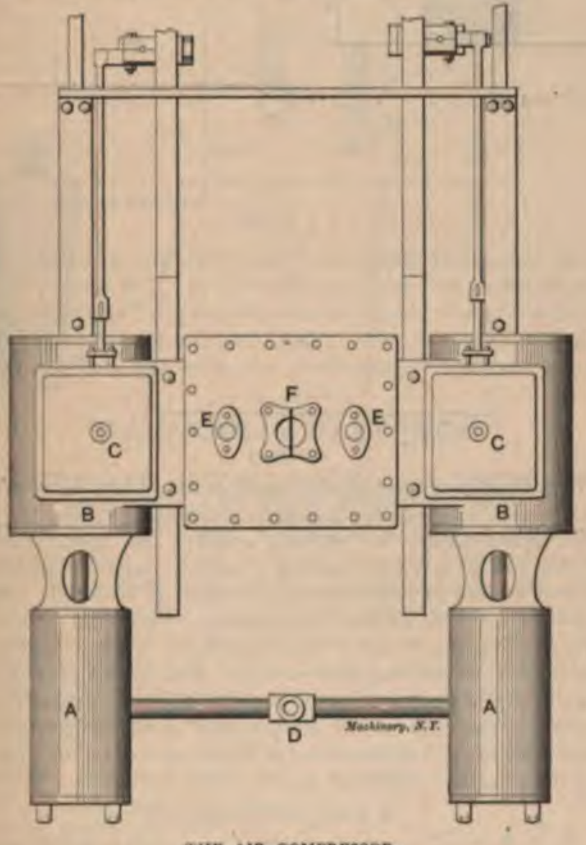


FIG. 18.

## A NOVEL AIR COMPRESSOR.

The usefulness of compressed air for shop purposes was naturally quickly recognized by many railroad shops as the air-brake apparatus proved a valuable object lesson showing the convenience and flexibility of this medium. While the efficiency of compressed air for hoists and similar purposes is undoubtedly much inferior to a well-designed hydraulic system, it is nevertheless much preferred on account of the greater freedom from freezing, absence of disagreeable leakage and its adaptability to driving high speed motors. One bad feature about the introduction of compressed air systems into railroad shops has been the proneness to use the ordinary Westinghouse air-pumps in series for air compressors. While the Westinghouse air-pump is undoubtedly an admirable machine for the purpose of supplying air to the brake apparatus of a railroad train, on account of its simplicity and freedom from serious derangement, it is nevertheless, a most wasteful user of steam. As is generally understood, this is a feature practically inseparable from any practical design of pump that does not involve the use of a flywheel as a reservoir of power to supplement the effect of the steam cylinder, as without the flywheel, the steam pressure must at all time be somewhat greater than the resistance of the medium being pumped.



THE AIR COMPRESSOR.

This fact has led the more progressive railroad shops to use air compressors that could be driven from the line shaft, or in many instances, an independent engine and compressor has been installed, but the latter has involved the expenditure of an amount of cash that has been prohibitory in the case of some railroad shops. The way that the Central Railroad of New Jersey shops at Elizabethport, N. J., have secured an independent compressor at little expense is interesting, especially, as their machine undoubtedly under favorable circumstances would show an efficiency equal to any ordinary commercial compressor. They have simply utilized the machinery of an old locomotive for the motive power and have added tandem cylinders to the steam cylinders for the air compressor cylinders. The arrangement is shown in its essential features with the exception of the main driver, by the plan view in the accompanying sketch. The boiler was removed, but the frames and cylinders were left intact with the main wheel, link motion, etc., which were mounted on a suitable foundation. A bearing for the main driver (or flywheel as it now is) was formed by simply turning the driver boxes upside down, the weight of the wheel being found sufficient to hold it down to its proper position since but little power is transmitted through the cranks. Each steam cylinder does the most of its work on its tandem air cylinder, and the feature of rotative action together with the link motion enables the cut-off to be set at the most economical point. As the value of the old locomotive from which the compressor was constructed could only be taken at its scrap price, it is evident that a very cheap and probably effective compressor was obtained.

In the sketch B, B, are the steam cylinders, and A, A, are the air cylinders which have water jackets with a constant circulation. The air delivery pipe is at D, and the steam connections are indicated at E, E, and F, F. The steam and exhaust pipes are not shown, but only the openings in the cylinders.

By a comparison between the summer and winter efficiencies of this compressor, the well known fact was forcibly illustrated that it is highly desirable to take the air supply from as cool sources as possible. This point is too often overlooked in the installation of compressors as in the present case, the air being taken from the engine room where in summer the temperature will range well up into the vicinity of 100° Fahr., and as the storage tank is located in the open air the compressed air is cooled down to the temperature of the surrounding medium.

While there is always an unavoidable loss in the utilization of compressed air under ordinary circumstances, it is perfectly clear that the lower the temperature of the air supply is kept, the less the loss will be from the cooling in the storage tank.

The difference in the work required of a compressor with the air supply at various temperatures can be very easily demonstrated without a very elaborate mathematical demonstration. For an example, we will assume the air supply to have two temperatures for a comparison, one being taken at 60°, and the other at 100° Fahr. The volume of a pound of air at various temperatures and pressures is found by the simple formula

$$V = \frac{30752\ T}{P}$$

so the volume of one pound of air supply at 60° would be

$$V = \frac{.37052 \times 520^\circ}{14.7} = 13.107$$

cubic feet. In this calculation the temperature and pressure is absolute so it is necessary to add 460° to 60° which gives 520° and as the air supply is at atmospheric pressure it will have an absolute pressure of 14.7 pounds. The volume of one pound of air at a temperature of 100° would be, as calculated by the same formula,

$V = \frac{.37052 \times 560^\circ}{14.7} = 14.115$ cubic feet or practically one cubic foot more and if we assume for convenience that the air compressor cylinder has a capacity of one cubic foot, also if we take the respective volumes to be in round numbers 13 and 14 cubic feet, it is evident that 13 strokes of the piston would be required to compress one pound of air at a temperature of 60° whereas 14 strokes would be required to compress the same weight to the same tension when the temperature is 100°. Now if in each case the compressed air be cooled to the same temperature in the storage tank, one-thirteenth of the work expended in the compression is uselessly wasted besides needlessly exposing the cylinder of the compressor to a higher temperature. The above calculation is correct only when no allowance is made for the effect of the cooling device or water jacket, as it is evident the higher the efficiency of the cooling apparatus the nearer the compression line approaches the isothermal curve. If the cooling jacket could attain an efficiency of 100 per cent., it would make no theoretical difference what the temperature of the air supply was.

* * *

Every machinist ought to be a draftsman to the extent of being able to delineate his ideas on paper so as to be clearly understood. A simple sketch will often express more than yards of talk.

* * *

Some manufacturers are very guarded as to their processes and are opposed to the publication of any details connected with their business and then there are others who are always willing to explain their methods without reserve. There are, of course, schemes in every shop that are in a measure private property, but the firms that are to-day doing the greatest amount of business are those that open their shops most freely to those interested.

# SHOP KINKS.

**A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.**

**Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.**

### JACK FOR STRAIGHTENING SHAFTING.

The rig shown in Fig. 1 is for straightening shafting or other work of a similar nature. It consists of a heavy forged piece A, the plate B, two blocks C C, and the screw D. The method of using the jack is so clearly shown in the sketches that further description is unnecessary.

"G," the contributor of the above kink, says that the crank disc of a large engine was cracked from the crank-pin hole to the outside of the disc but was permanently repaired by shrinking a heavy wrought iron band around the disc and replacing the crank-pin by a new one which was threaded for a nut on the inner end. The combination has proved effective since it was repaired in this manner a number of years ago, but to all appearances is as solid as ever.

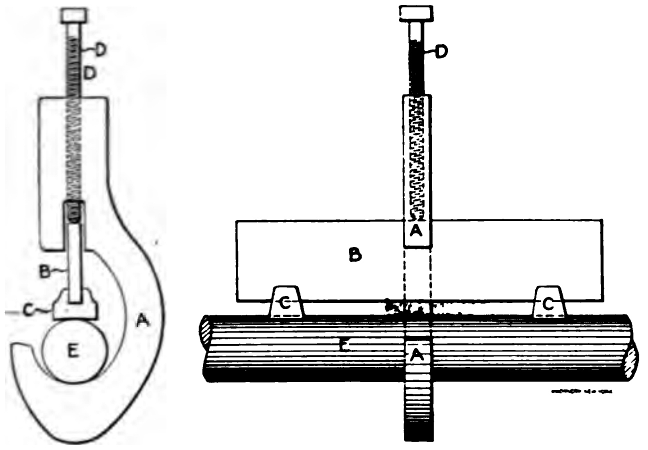


FIG. 1.

### TO SAVE LABOR IN MAKING SLOTS, ETC.

Mr. George L. Renneisen of Louisville, Ky., says that a lot of 2½" rods were to be slotted one inch from the end, the slots to be ¾" X 2¼". After laying out the slot on a rod, three holes ¾" in diameter were drilled to remove the stock and then the holes were plugged. The intersections of the three holes were then drilled out and the small ridges filed off with a minimum of labor. It is a common practice with some machinists to chip out the spaces left after drilling the first holes, but by following this practice considerable time and labor is saved.

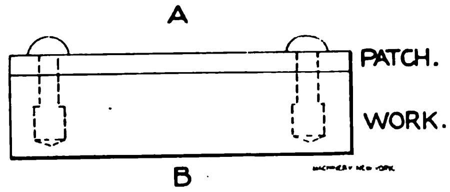


FIG. 2.

A kink that is of considerable value when riveting a piece of brass onto a thick slide or on similar work is to drill the holes for the rivets about two-thirds of the desired depth and then to grind the drill "off center" a small amount. The holes being drilled to the desired depth with this form of drill will be found larger at the bottom than at the top so when a rivet is driven home it expands at the bottom and is there to stay.

### SOME BUFFALO KINKS.

Mr. Wm. W. Galloway, of Buffalo, N. Y., says that a useful rig for truing up worn crank-pins is shown at A A, Fig. 3 and that it consists of two blocks of hard wood fitted together with dowels B B and bored out to the smallest diameter of the worn pin. The method of using it consists of covering the interior C with red lead and placing the two parts together over the pin which will thereby be marked with the lead on the high parts. The high parts are then chipped or filed down until the block leaves a uniform coating of lead all around the pin.

While such a method is slow and not as good as removing the pin and turning it in a lathe, it is far superior to not doing the job at all which would usually be the result if the crank-pin had to be removed.

A kink in tapping holes that are so situated that a square cannot very well be used to test the truth of the tap for squareness, is to run a faced nut onto the taper tap, start the tap in the work, and then run the nut E down next to the face of the work G. A wrench F is then placed on the nut to hold it and the tap screwed into the hole with the result that the threads will be square with the face of the work.

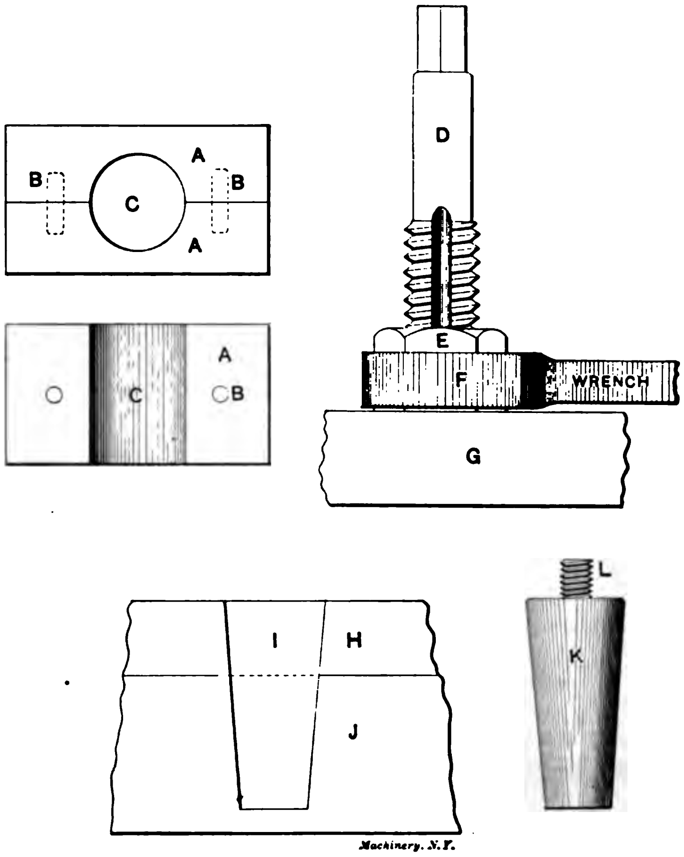


FIG. 3.

If a dowel-pin holding two metal parts, H and J, in a certain relative position becomes lost and it be difficult to take the necessary measurements for making another pin, much time and trouble can be saved by running a babbitt plug into the hole and around a piece of threaded rod as shown at K and L. The interior of the hole should be examined previous to pouring the babbitt to see that it is free from blow-holes which would prevent the removal of the plug after cooling. With such a plug the making of the new dowel-pin is a comparatively easy matter, as all the necessary sizes are at the convenience of the lathesman. The reason for using a threaded rod is that a nut can be used for starting the plug out of the hole should it stick fast.

### A RING CUTTING DIE.

"E. J. F.," of Toronto Junction, Can., sends a sketch of a ring cutting die which is designed for cutting off sections of wire coils, the coil being slipped over the die B which has a notch cut for clearance to the cutter A. Different sized dies can be used in the bolster plate C, the change being effected by loosening the setscrew D. "E. J. F." says that he has used the die in the shop where he is employed with great success, and that if the wire is coiled tightly together the rings will come out with their ends truly in line.

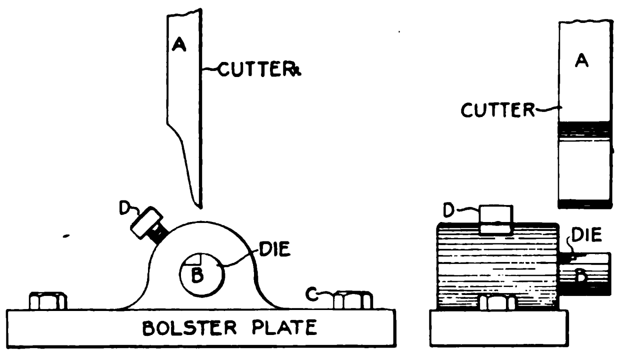


FIG. 4.

### CLAMP FOR HOLDING WORK ON FACE PLATE.

J. E. S., of Harrisburg, Pa., says that a useful and handy form of clamp for the face plate of a large lathe is that shown in Fig. 5. At least four should be provided which can be arranged equidistantly around the face plate at the required distance from the center. This clamp is most useful on rings and similar work as they enable it to be firmly held without springing. In the sketch A is a casting with two jaws C C, which are tapped for the cupped screws B B. It will readily be seen that a circular piece, having a section like that of D, can be readily chucked with practically no danger from springing if any care is taken by the operator even if the work is of comparatively light character.

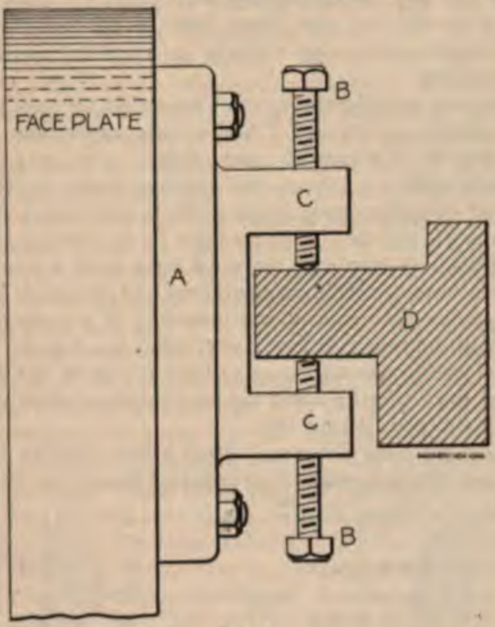


FIG. 5.

* * *

## MALLEABLE CAST IRON.*

### WHAT IT IS AND IN WHAT RESPECTS IT DIFFERS FROM CAST IRON AND FROM WROUGHT IRON.

Malleable cast iron may be roughly defined as occupying a halfway position between ordinary gray cast iron and wrought iron, as it possesses some of the qualities of both. This definition is not technically accurate, but serves rather to designate the place occupied by malleable iron in the commercial world.

Ordinary cast iron is a very complex alloy of iron with carbon which exists in several forms: Silicon, phosphorus, manganese, sulphur and small proportions of other elements. As we all know, it can readily be cast into intricate shapes. It cannot be bent or forged, and it is brittle under shock, especially in light sections. Wrought iron, in its most refined form, is practically pure iron, and can be easily forged, and can be bent or twisted even when cold without fracture. It cannot easily be cast, but can be welded, a property not possessed by cast iron.

Malleable cast iron, or malleable iron, as it is commonly called, is made from pig iron low in silicon, sulphur and phosphorus, and from which the carbon has subsequently been largely removed by annealing at a red heat in iron ore, mill scale or some other porous or infusible substance. When cast the iron is white in fracture and as brittle as glass, owing to the carbon which is present to the amount of about 3½ per cent., being in chemical combination with the iron. During the annealing at a red heat the carbon, which is at this temperature in a state of solution in the iron, gradually diffuses. As it comes into contact with the surrounding packing it is oxidized and passes off as a gas which can be seen burning at the cracks in the clay luting of the pots. There is a variable amount of carbon retained in the casting, but it exists in a form like graphite in ordinary cast iron; that is to say, it is disseminated throughout the mass somewhat as mica occurs in granite. The flakes of graphite lie between the particles of iron, and form, as it is said, "planes of weakness." The diffusion of carbon in iron, even at a bright red heat, takes place slowly, and hence only castings of small cross-sections can be decarbonized to any appreciable extent. In castings less than ¼ inch in diameter practically all the carbon can be removed.

We have, then, as a result of the two processes, casting and annealing, a product which has first been formed in any desired shape and by its subsequent treatment converted to a state approaching wrought iron. We should therefore expect its physical properties to be between those of cast and wrought iron, and this we find to be the case. Its tensile strength, 45,000 pounds to 52,000 pounds per square inch, is more than cast iron, but slightly less than wrought iron; its elongation of 3 to 7 per cent. is much greater than cast iron, which is practically nil, and much less than wrought iron. We find, on trial, that malleable iron can be bent or twisted and forged to some extent, but not so much as wrought iron. The preceding remarks apply to light work, say to an inch in thickness or less. It is proper at this point to speak of another function of the annealing process as applied to heavy work, such as casting for farm implements and car couplers. As before stated, castings of this class cannot be decarbonized to any appreciable extent, but they are rendered soft and strong. Such articles cannot be bent as much as the decarbonized castings, owing to the graphite forming planes of weakness, as noted above. We have, then, two classes of malleable castings, the small decarbonized articles and the larger articles containing nearly all their original carbon, but in a changed form. Each class of castings is admirably adapted for its own purpose. It may be questioned, if both classes are equally strong and soft, why is it necessary to decarbonize the smaller castings merely to increase their toughness? The answer is that in small work this quality is essential. Many small articles (bits, for instance) are cast open and "closed up" after inserting a ring; or, in assembling bits, parts are frequently upset or headed like a rivet. Thus, for small work it is highly desirable to have decarbonized iron to obtain the bending and cold forging properties.

The first malleable iron castings of domestic manufacture were produced in Newark, N. J., in 1826. Seth Boyden, to whom belongs the honor of doing this, was a native of Foxboro, Mass., but settled in Newark, in 1815, when in his twenty-seventh year. As a boy he worked at farming and occasionally at a furnace operated by one of his uncles. He attended school for only a few short terms, but this by no means ended his education, for he continued his studies by himself, especially in those natural sciences that would aid him in his labors. He showed to a very marked degree the traits of the stock from which he sprang. Mechanical ingenuity and skill with tools came to him naturally. During the course of his long life he was occupied with many of the arts and sciences, and so great were the benefits conferred by his many inventions and improvements on existing processes that the citizens of Newark have erected a statue to his honor.

* * *

A recently patented rotary engine bears a startling resemblance to a style of sausage machine that was quite popular a few years ago. The engine has three rollers, however, instead of two, but the helical flutes with a variable pitch show quite conclusively where the misguided inventor probably obtained his idea. The number of rotary engines patented each year indicate a waste of time and money that might better be directed where the chances of receiving some returns are more promising.

* * *

The electric locomotive constructed by Brown, Boveri & Co., destined for the Jungfrau Mountain Railway, is said to be the most powerful rack-wheel machine hitherto constructed, and is designed to haul trains over the steepest portion of the road. The motors are placed under the passenger cars, whereby greater adhesion between the driving-wheels and rails is obtained. The car truck is provided with two bearing axles and two driving axles, the latter being situated between the former. Two motors, each of 125 H.P., at 800 revolutions per minute, actuate the toothed wheels through the medium of duplicate gearing. If required, these motors are capable of working up to 300 H.P. The driving current is conveyed overhead at a tension of 500 volts. The pivots of the toothed wheels are of aluminum-bronze, the teeth being of cast-steel.

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* Geo. C. Davis, in the "Journal of the Franklin Institute."

# LETTERS UPON PRACTICAL SUBJECTS.

## MAKING IRREGULARLY SPACED REAMERS.

*Editor* MACHINERY:

Following is a sketch and description of a method for making fluted reamers with irregular spaces, which, whether the reamer is straight or tapered, have the property of lessening the chatter and making smoother holes. The method for spacing the flutes of such reamers is shown by Figs. 1 and 2 and is explained as follows: A list of divisions should be made out which will require an unequal number of turns of the index crank for each indexing, but the sum of these turns must equal the total number of turns necessary to give the work one full rotation. For an ordinary dividing head which requires forty turns of the index crank for one turn of the work, a list of divisions may be made out as below which is for cutting six teeth. The turns of the index crank for the successive flutes are: 5½ +.6½ + 6 + 7½ + 7 + 7½ = 40. For dividing with a simple index plate a similar list may be made out.

The cutter should be set so as to leave a proper thickness of land as at E F in Fig. 1, and the relation of the mill to the work should not be altered until the job is complete. The dividing should begin with the smallest number of turns in the list which in this case is 5 1-2, and should be carried through with the different numbers of turns as given in the list.

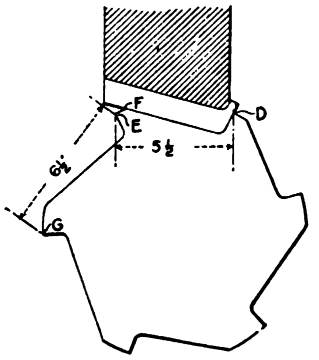


FIG. 1.

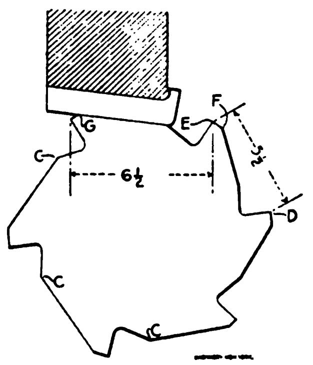


FIG. 2.

Fig. 1 shows the result after going around the work once, the spaces being all of even width but some of the resulting teeth are very thick. The last indexing on the list (7 1-2) will bring the cutter into the first space cut and by indexing in the same order again the cutter would simply pass through each flute without cutting. If, however, after getting around the work the first index is skipped and the cut is started with the index of 6 1-2 turns and continued around the work in the order of the list as given, the lands will all be milled to the same thickness as shown in Fig. 2. The reason for this is that instead of indexing as at first from the face D to E (5½ turns) Fig. 1, by skipping an indexing the work is indexed from point F to G (6½ turns) Figs. 1 and 2, and so on around the reamer. The faces and backs of all the teeth are all at the same angles so that in grinding the reamer to size one tooth will not widen more than another. The slight lumps at C C C, Fig. 2, are readily removed on an emery wheel so that the resulting reamer is scarcely noticeable from an evenly spaced one.

Meriden, Conn. JAMES P. HAYES.

* * *

## CHAMFERING CUP LEATHERS, ETC.

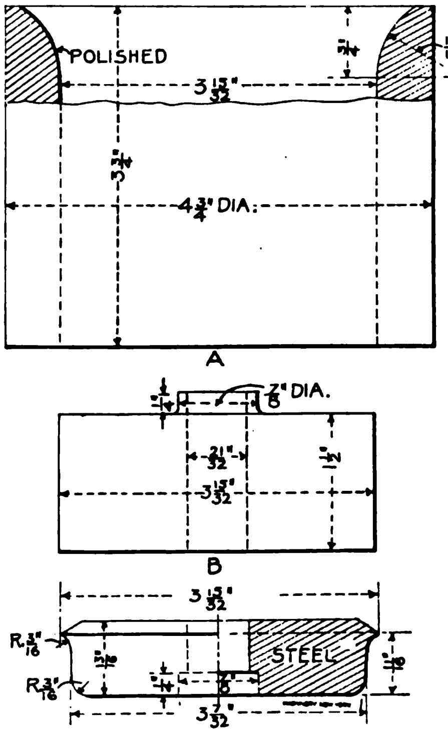
*Editor* MACHINERY:

I noticed in the July issue of MACHINERY an item about making cup leathers which referred more particularly to chamfering the edges. A blue print is enclosed which shows the way I have been doing it and which makes a beautifully formed cup. A is a sleeve which is bored about 1-32" smaller than the cylinder in which the cup is to work, B is the follower and C is the cup former. The cup former is made of steel of the dimensions indicated in the sketch with the edge R turned to an angle of about 60° and case hardened. The sharp edge of the cup former C being such a close fit in the sleeve A the surplus leather is trimmed off as neatly as if done with a sharp knife and the fillet under the edge leaves a handsome chamfer on the cup leather.

Did any reader ever melt babbitt in a blacksmith's forge and when ready to pour seize the handle in a "hunk" of waste and, at a critical moment, have the hot handle burn through the waste? If so the next time a ladle outfit is made, slip a piece of gas pipe over the handle before bending it. Keep the piece of pipe up next to the handle until ready to carry away the ladle, then slip the pipe down next to the bowl and a cool handle is the result, also a sleeve in which to turn the handle when pouring.

I read with considerable interest the article on step-bearings, as about fourteen years ago I had a little experience with them which may be of interest to some readers. One case was that of an upright shaft in a flouring mill carrying several bevel gears and a number of pulleys making altogether a very heavy affair. The shaft was 4", 3½" and 3" in diameter in its various sections and about sixty feet long with the usual taper steel pin running in a steel step, both of which were hardened and flooded in an oil bath. Although the arrangement was furnished by a prominent manufacturer of flouring mill machinery, there was trouble right from the start and it was necessary to have it sent to the shop every few days until I finally asked the proprietors to allow me to fix it and received their permission.

I raised the shaft about 12", fitted a half coupling on the end and coupled to it a piece of forged iron shaft 5" in diameter and 12" long. A phosphor-bronze disc 5" in diameter and ¾" thick was made to take the thrust and was secured from turning in the cast-iron box by two 5-8" pins. A groove was cut across the upper face of the phosphor-bronze disc about ⅛" wide and ⅛" deep to insure a plentiful supply of oil to the rubbing surfaces. The usual step-box surrounding the shaft was supplied, holding about one quart of oil.



DIES FOR CUTTING CUP LEATHERS.

After the step-bearing was changed in this manner, the miller never had a moment's delay from heating although previously the mill had been nearly fired a number of times by its getting hot.

Another case is that of a "rubbing wheel" in a stone yard with which there was the same difficulty that was encountered in the flouring mill. The wheel weighed about ten tons and the diameter of the lower end of the supporting shaft was 6". The builders had provided a thrust bearing composed of a nest of bronze and steel washers about 3-16" thick (four of each) and running in oil.

I fixed this bearing in the same manner as the mill shaft and results have proved equally as good as there has never been any trouble with it since. E. S. NEWTON.

Fond du Lac, Wis.

## ANOTHER SHOP SYSTEM.

*Editor* MACHINERY:

Having read a number of articles from contributors to MACHINERY in regard to various systems of keeping the time of employees in different shops, I desire to say a few words about the system I have installed in the shop where I am at present employed. The shop I speak of builds a regular line of machines together with a large jobbing business and special machinery. When I entered the employ of the firm the time of each employee was kept by himself. It was kept upon cards blocked into pads with the employee's number at the top, and he was supposed to keep a correct account of his time for each day, write it on one of his cards at night and place the card in a box provided for that purpose. It is needless to say that very little work was done from 5.45 till 6 o'clock, but there always was a great amount of guessing done in that time by each employee as what to put his time down to. It being one of my duties to look the time cards over the following morning it would seem to me his whole ambition was to make sure he had ten hours on his card and let it rest at that. When I came to enumerate the different jobs to be found upon those time-cards I would find ¼ or ½ hour, or possibly more on one job when it should have been on another job. At the same time an employee was allowed to come into the shop at morning and at noon with no one to take his time and no place he could register it. I was constantly being called into the office and nine out of every ten times the two following questions would be asked me: Was so and so in on time this morning? By the way, did number so and so have as much time on the job he was working on yesterday as he had on his time card? I soon got tired of the foregoing dialogue every day, and set myself to the task of installing a time system that would be correct and at the same time not to use fifteen minutes of each workman's time every day in making out time cards. The first move I made was to inaugurate a system whereby each employee might register his time at his arrival and departure. The plan adopted was as follows: I had some cards printed as illustrated in No. 1, I then had two racks made with spaces to fit the card and enough for the number of men employed. I had these racks placed in an accessible spot and marked one In and the other Out. When an employee entered the shop prepared to work he handed his card to the foreman who registered the exact time he entered, after which he placed the card in the rack marked In; when he left at noon he again presented the card to the foreman who registered the time he stopped work and the card was then placed in the rack marked Out, the same operation being used for p. m. as for a. m. As the shop had pay-days semi-monthly the necessity of using a two-weeks' card was at once evident. As can be seen the card is divided into spaces marked with the first letter of each day, and those spaces are again divided and marked a. m. and p. m. The length of the card is divided into five spaces, the first two marked In and Out are for the first week and the next two marked the same are for the second week, the last one marked Total is for the number of hours. When the employee has registered two weeks on his card it is taken into the office and the number of hours added and placed at the bottom, the employee's rate is placed below and his whole time is figured on his working card. As I stated at the commencement of this article the shop builds its line of tools as well as doing a large jobbing trade, also stating the trouble I had with the men keeping their own time. I then saw the necessity of completing the system and put in use a time card where each employee could keep his time on each job correctly. This card I will number 2 for distinction. A regular order book is in use and all jobs, whether for repairs or machines, are written in this book and an order number placed opposite, for example:

July 20,
Weed and Baker,
6 Bench Lathes NO. 779.

Working Time
OF

No. 1.
Name, Brown.
July 29, '99.

| Day. | | In. | Out. | In. | Out. | Total. |
|---|---|---|---|---|---|---|
| M | A. M. | 654 | 1204 | 651 | 1207 | 10 |
| | P. M. | 1254 | 602 | 1245 | 603 | 10 |
| T | A. M. | 656 | 1202 | 650 | 1203 | 9½ |
| | P. M. | 130 | 602 | 1249 | 605 | 10 |
| W | A. M. | 700 | 1201 | 714 | 1208 | 5 |
| | P. M. | | | 1250 | 608 | 9¾ |
| T | A. M. | 715 | 1204 | 7 | 1205 | 9¾ |
| | P. M. | 1250 | 603 | 1250 | 604 | 10 |
| F | A. M. | 658 | 1203 | 640 | 1204 | 9 |
| | P. M. | 1257 | 5 | 1257 | 601 | 10 |
| S | A. M. | 659 | 1206 | 654 | 1203 | 9 |
| | P. M. | 1257 | 5 | 1250 | 5 | 9 |
| S | A. M. | | | | | |
| | P. M. | | | | | |

Total Hours, 111.
Rate per Hour, .24.
To al Cost, $26.64.

FIG. 1.

THIS SIDE OUT.
COST CARD.
Job Order, 779.
Cost, ..........
Commenced, July 21.
Completed, July 25.

Name of Machine, Bench Lathes.
Names of Parts, Cones.
No. of Machines, 6.
No. of Parts, 6.
Operation, Finish.
Repairs, ..................
Order No., 779.

Correct, H., Foreman.

FIG. 2. FRONT.

Working Time
OF

No, 5.
Name, Jones.
July 21, 1899.

| Day. | | In. | Out. | In. | Out. | Total. |
|---|---|---|---|---|---|---|
| M | A. M. | | | | | |
| | P. M. | | | | | 10 |
| T | A. M. | | | | | |
| | P. M. | | 315 | | | 7¾ |
| W | A. M. | | | | | |
| | P. M. | | | | | |
| T | A. M. | | | | | |
| | P. M. | | | | | |
| F | A. M. | 8 | | | | |
| | P. M. | | | | | 9 |
| S | A. M. | | | | | |
| | P. M. | | | | | 9 |
| S | A. M. | | | | | |
| | P. M. | | | | | |

Total Hours, 35¾
Rate per Hour, 20.
Total Cost, $7.05.

FIG. 2. BACK.

An employee goes to the foreman and is out of a job; the foreman wishing him to finish the cones for the lathes in the above order, makes out a time-card (No. 2) with the description of the work to be done and the number of pieces to be finished on one side of the card, on the opposite side he writes the employee's name and number and the exact time it was commenced, and when the work is completed the workman returns his work together with his card and if found satisfactory, the foreman writes the time it was finished. The time is then carried out into the space marked Total, again the total is carried to the bottom of the card together with the workman's rate, which is figured and gives the cost of finishing the 6 cones, which is marked on the opposite side. A new card is used for every part, the same being placed on file till the job is completed, when they are

| No. Pcs. | MATERIAL. | Wt. | Feet. | In. | Cost. | |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| 6 | Cone castings. | 64½ | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

MATERIAL.

ORDER No. 779.

| Hour | Min. | |
|---|---|---|
| 7 | | ISSUED<br>July 21. |
| 3 | 15 | COMPLETED<br>July 25. |

H., Stock Clerk.

FIG. 3.

taken all together and figured, the product being the actual cost of the machines; at the same time we have the actual cost of each part. As to the use of the card for jobbing, it gives the actual time on each job as well as relieving me of my morning calls at the office, for the clerk knows the cards tell nothing but the truth. As time went on and I found this system was a success I began to think of putting into operation a system of keeping stock, having at that time become aware that there was a leakage from that source, also to know the actual cost of work I must know the amount of stock used. For that part of the system I adopted card No. 3. When an order came and it was time to start work on same the material to be used was looked after; as seen by card No. 3 the stock was weighed one hour before the foreman signed the time slip. As it passed through the foreman's hands and went to the office the two were compared, showing that the foreman was attending to his business and had the stock weighed one hour before the workman began to finish same. It is part of my duties to weigh the castings for each machine and at any time after I can always find the weight of the machine complete, or of any of its parts by simply referrng to those No. 3 slips.

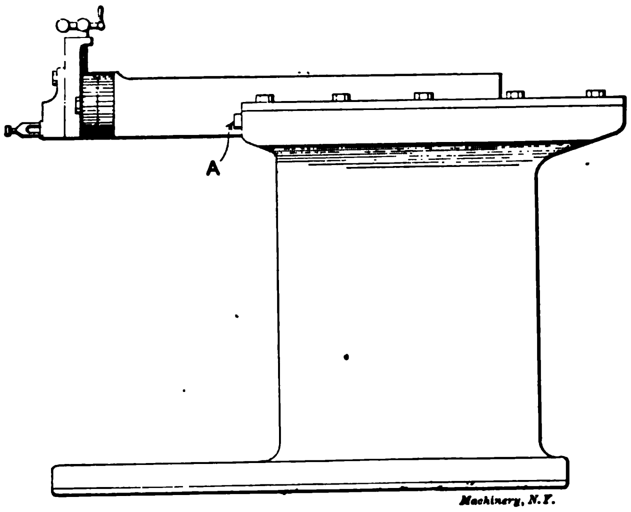
Providence, R. I. A. F. HORTON.

* * *

## ABOUT THE FORM OF A SHAPER RAM.

*Editor* MACHINERY:

I have read with considerable interest the letter in the May MACHINERY by Mr. Hill on "Shaper Designs," and can agree with him that it is highly desirable to obtain a machine in which the shaper ram will be as stiff to resist an upward spring when at the limit of travel as when close to the frame. The utter unreliability of the shaper to produce work which has the feature of parallelism in the opposite sides, is a fatal drawback to a machine which otherwise would be one of the most useful tools in the shop. Even as it is with the faults of inaccuracy and lack of stiffness in the knee, many shops make extensive use of it on work that does not perhaps require the greatest accuracy. If the shaper could be so built that it would be capable of turning out work as nearly parallel with the surface of the table as that produced by the average planer, it is evident that its field of usefulness would be greatly extended.



A SHAPER SUGGESTION.

While the planer is usually a somewhat massive tool, it does not depend entirely on its strength for the accuracy of the work turned out, but rather on the feature of uniform deflection in the parts that resist the strain imposed on the tool. Practically no machine can be built so stiff and massive that it will not spring more or less under the strain of the cut, but by reason of the form of construction of the planer, the tool while deflected upwards by the work is no more influenced in that direction at the end of the stroke than at the beginning. In the shaper this is not the case however, but the deflection increases with the length of the stroke. Now, since the spring of the ram and a certain slackness in the slides are features that cannot be overcome practically why not attack the problem in a logical manner and start with the assumption that a certain deflection of the cutting tool is unavoidable, but if it can be made uniform the results will be uniform.

The method which I would suggest for accomplishing this desirable result is not to stiffen the ram to an abnormal extent, or necessarily change its form as suggested by Mr. Hill, but is simply to cut off the supporting slides of the ram at the point A even with the frame, when the ram is at its extreme outer position. The result is that while the stiffness of the ram is impaired for work that comes close to the frame of the machine, it is not damaged for operating on work at the limit of the stroke and as the spring of the tool will be uniform at all points in the stroke it follows that the work planed must be parallel providing the knee is properly supported which is another question.

I will leave it to the readers of MACHINERY if it would not be more desirable to secure a medium degree of stiffness in the ram and to have it uniform than to secure great rigidity at the beginning and a more or less unstable support at the end of the stroke with the resulting "fan tail" product. F. EMERSON.

Newark, N. J.

* * *

## WHERE IS HE?

*Editor* MACHINERY:

Some years ago a gentleman came to my place of business, claiming to have a process of converting wrought or malleable iron into tool steel. He had quite a collection of samples, and among other things was a blade, like a pocketknife blade, forged on the end of an old horseshoe; several cold chisels made from railroad spikes, and three or four malleable-iron hatchets for lathers. I have no reason to doubt that all of the articles were genuine. The pouring gate was very plain on the hatchets and the eye was cored without doubt, as was also the checkered face. The general appearance indicated malleable iron. The cutting edge was blunt, necessitating being dressed at the forge, which I did, and they worked in every way as if they were genuine tool steel and took excellent temper, they having previously been subjected to his process. After dressing these hatchets they were ground and whetted to a very keen edge—so fine that they would shave very nicely; then they were subjected to all manner of abuse, such as chopping hard wood, knots, sandy timber, and, lastly, chipping castings, bar-iron and wire nails without any such effect on the cutting edge as might be expected. The horseshoe blade was stropped to an excellent razor edge and then subjected to such brutal usage as the cutting of wire nails and other metals, and, contrary to expectations, this blade would then shave very nicely.

In my experience of twenty or twenty-five years with steel I have never before or since seen any tools, hand or machine forged, of any grade of steel, or tempered by any process, that would stand the test that was given these samples. Having at that time no immediate use for the process, and being very busy fighting "the wolf," I sent him to an acquaintance who was a manufacturer of edge tools. There he "monkeyed" around for a few days and disappeared as suddenly as he came.

As I am now in a position where I could use this or a similar process to advantage I write this with the hope that some of the readers of MACHINERY can locate the gentleman or give some light on the process. HUGH HILL.

Anderson, Ind.

* * *

## SOME NOTES ON CUTTING PIPE THREADS.

*Editor* MACHINERY:

In cutting threads on pipe the aim is to cut a thread, which, when screwed into a fitting, will make a steam tight joint without the use of red lead, graphite, etc., but owing to numerous causes this result is not always obtained. When the threads, both in the fitting and on the pipe are in good condition, graphite and oil put on the threads will be sufficient to make the joint steam tight, also facilitate the separating of the fitting and pipe when that is necessary. When the fitting and pipe do not screw tight, the result of the thread being cut too deep or some of the thread being broken, the joint may be made steam tight by using red or white lead, but when this is used it will be quite hard to separate the fittings and pipe after the red or white lead has hardened. Sometimes the joint is caulked, but when this is needed the cutting of the threads has been improperly done, and it would be better to cut and properly thread another piece of pipe, although in some cases caulking must be resorted to.

When screwing a piece of pipe into a fitting be sure that it enters far enough to be secure. One or two turns is not sufficient and many dangerous connections are made by overlooking this little point. Sometimes the thread on the pipe is not cut deep enough and when screwed in one or two turns it "feels" tight and is left as "all right," with the result that sometime afterwards there is a "mysterious steam pipe explosion."

In cutting a thread on a piece of pipe, if after turning the stocks around and applying proper pressure the thread does not start, the trouble may be a burr or some other slight imperfection on the outside of the pipe. This should be filed away all around the pipe then the thread can be started all right.

When cutting threads on short lengths of pipe for nipples, they may be so short that they must be held with a coupling to another piece of pipe which is held in the vise; when such is the case the coupling prevents the bushing from passing its proper distance on the pipe, if the nipple is very short the bushing may be placed on the other side of the coupling, then the bushing is placed in the stocks as far as the coupling will allow it, then bring the dies to cut; after a few threads have been cut the bushing will go into the stock its proper distance and the set-screw can be tightened, then the rest of the threads are cut. When removing the stocks and dies from the pipe, first loosen the set-screw holding the bushing in place. When the nipple is so long as not to admit the bushing being placed on the other side of the coupling use a bushing that will go over the coupling; if it is too large, paper may be wound around the coupling which will lesssen the liability of cutting the threads out of line with the pipe.

**Chas. G. Peker,**

New York City.

* * *

## DETAILS OF A STEP BEARING FOR HEAVY DUTY.

*Editor* Machinery:

The article on step-bearings in the July issue has called to mind a bearing of this class which was used in a shop where I was draftsman a few years ago. This shop made stone working machinery, principally, and Fig. 1 shows the iron work of one kind, called a rubbing bed, for polishing the surfaces of stone used in building, etc. This was set in a suitable timber frame-work, with one piece of timber reaching across from one upright to another, just behind the spindle and about one inch above the table. When in use the stone was laid on top of the table and the above mentioned timber kept it stationary while the table turned around underneath. At the same time a mixture of sand and water was kept running onto the table which made a sort of grindstone of it. Fig. 2 shows the bottom of the spindle and also the step-bearing. The bottom casting was square with a turned up flange to keep the upper casting from turning and it also had a ball and socket joint in the center. The bushing was made of brass, keyed into the step casting and was a running fit on the pin. The pin and buttons were made of the best grade of tool steel, hardened glass hard and when finished these buttons were about 1-32" full thicker in the center than at the edges, but before being hardened they were made thicker at the edges, as after going through the hardening process they swelled in the middle. Of course the end of the pin was hardened also and showed a bulge in the center of about 1-32". The bottom of the pin, both sides of the two upper buttons and the top surface of the bottom button had grooves as shown in Fig. 3. The bottom button was held in place by two ¼" dowel pins. The pipe at the left is used for filling and when turned down for emptying the bearing of oil, the best lard oil being used. There was a washer of leather over the bearing around the pin to keep out the dirt and grit. The weight on this bearing was 22,000 pounds made up as follows: The table was 12' 6" diameter, 4½" thick with a 48" hole in the center.

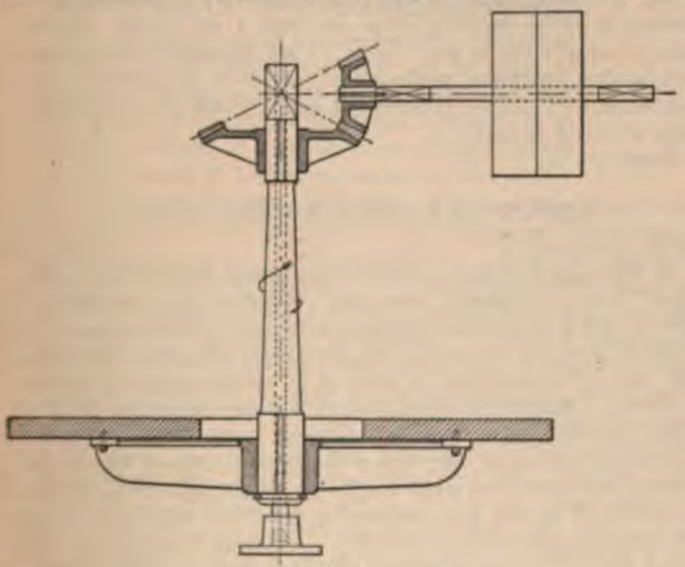


FIG 1.

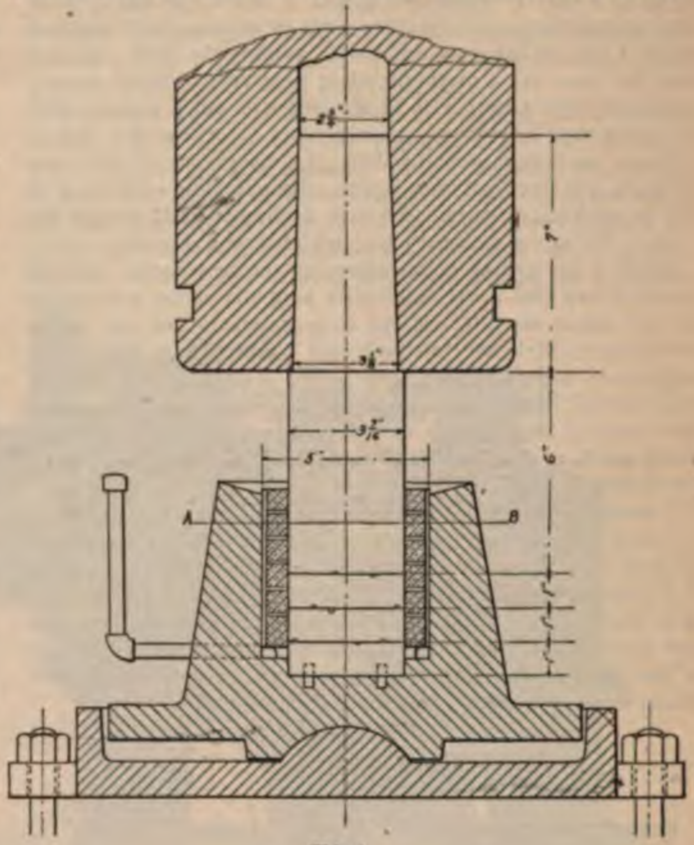


FIG. 2.

| | | | |
|---|---|---|---|
| Weight of | table | 19,050 | lbs. |
| " " | spider | 1,484 | " |
| " " | gear | 350 | " |
| " " | spindle | 1,150 | " |
| Total | | 22,034 | lbs. |

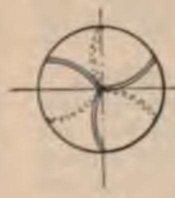


FIG. 3.

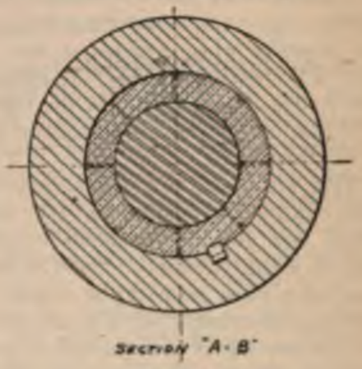


FIG. 4.

This was increased by the weight of the stone, sometimes a ton or more. The pulleys run 72 r.p.m., the gears were 2 : 1, the spindle making 36 r.p.m. This bearing ran for years without any trouble whatever.

**F. W. Seidensticker.**

Chicago, Ill.

* * *

## SOME CRITICISMS.

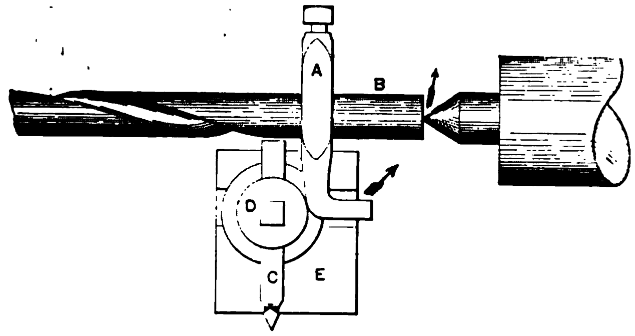
*Editor* Machinery:

In regard to the method shown by W. C. M. in the August issue of Machinery for holding twist drills when drilling in the lathe, I would say that it is not quite right, since the tendency is to throw the end of the drill in the direction indicated by the arrows. In a casting having any blow-holes the result is likely to be a broken drill, and to my knowledge it has been the cause of breaking three large drills of about 1½" in diameter. Another method, which is nearly the same as that given but much safer, is to place the end of the lathe tool as near the drill as possible thus bringing the point of resistance nearer the line of the centers. I have preached this gospel to machinists and apprentices for ten years, and the three cases of broken drills occurred where I did not insist on my way of holding the drill. In each case the man was a machinist of at least twenty years' experience, and right here I wish to say that it is not a pleasant task to handle men from ten to twenty years older than the "boss."

Some machinists seem to think that by reason of age their methods are best, yet they never read anything pertaining to things mechanical, saying that such reading is good enough for "cubs," but is not necessary for men of their experience.

While I am writing about others an incident comes to mind which shows that many machinists hold the editor responsible for any views aired by various correspondents that are wrong according to their way of thinking. Again, I have loaned my mechanical papers to men who would say "Who didn't know that before?" or "I have forgotten that years ago." It seems that some of these parties have forgotten a great deal or never knew much, as their work and methods speak volumes of things "forgotten."

I become very "tired" when a machinist who has forgotten so much clamps work to a planer or lathe with the bolts from 4" to 6" from the work and the blocking close to the bolt, when it is possible for him to have it just the other way, yet the same man when using a bar to pry a heavy casting from the floor will get the heel or fulcrum close to the piece to be raised. Why is it that they can so seldom see the similarity between the two cases, especially when it is pointed out to them?



DEFLECTING ACTION OF TOOL-POST ON DRILL.

Another thing that is common amongst machinists of the forgetful class is the use of a hand hammer to drive out a tight bolt or mandrel when perhaps a fifty or seventy-five-pound ram would be none too heavy. It seems difficult to "hammer" into the brains of this class that the light blows upset and rivet the end that is being driven instead of driving it out.

Emsworth, Pa. A. MERTES.

[We are aware that many readers of technical journals hold the editors responsible for the views of correspondents and think that nothing should be inserted in the reading columns that is at all "heretical," but it is by the exchange of these new and what often seems to be palpably erroneous ideas that some fact may be brought out of great value. Judging from the changes in the methods of doing machine work in the last score of years no class of artisans can as little afford to be narrow-minded as the machinist.—EDITOR.]

* * *

## SHAPER SLIDES.

*Editor* MACHINERY:

In the May issue of MACHINERY Mr. Hugh Hill suggests a method which will in his opinion tend to eliminate the "fan tail" planing action of the shaper and produce work in which the opposite sides are nearer parallel. While fully agreeing with him that a "camel back" ram would insure greater rigidity, it is evident that without a rigid slide, the greater strength of the ram does not avail. To illustrate the point Fig. 1 shows the form of slide generally used which has the top gibs fastened to the frame by cap screws. If the gibs were kept clamped tight by the cap screws they would be fairly rigid, but in order to allow the ram to run freely, it is usually necessary to slacken back the screws a little thereby giving practically a loose gib. Is it any wonder then that the cutting tool plays "hide and seek" with the work being planed?

At a recent exhibition, a really well designed shaper in all parts with the exception of the ram slide, claimed considerable attention. The attendant who had a piece of work in the vice was illustrating the quick change of stroke, speed, etc., and while doing so he made the statement that the shaper would accurately plane a piece of work full length. I asked him if it would do so without adjusting the gibs and his reply was that "it is not necessary to adjust anything." With his permission I tried the cap screws on the top gibs and was able to tighten each one nearly half a turn with my fingers. The shaper ram must have been dizzy from playing see-saw.

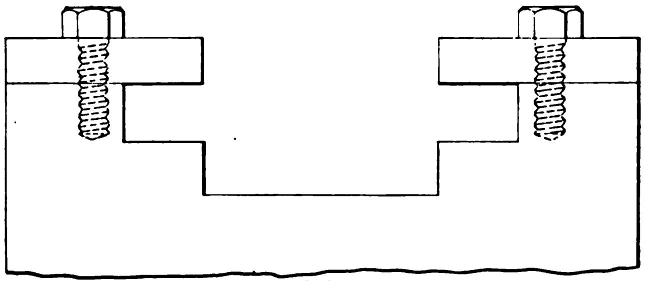


FIG. 1.

In my humble opinion a slide like that shown in Fig. 2 would insure more stability to the ram. The V groove is cut in the frame and fitted with one gib which, as will be noticed, is adjusted by a double row of screws, giving a full bearing to the gib.

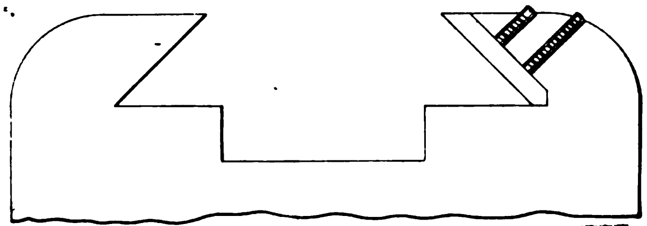


FIG. 2.

Mr. Hill also states that he finds shapers very small in proportion to other machine tools also that a 30" shaper should take as large a cut as a 30" lathe. I am obliged to differ with him in this statement as the power required to overcome the friction in a 30" shaper running full stroke would run a 30" lathe with a fairly heavy cut. T. B. C.

Brooklyn, N. Y.

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## ABOUT THE POWER PRODUCER.

*Editor* MACHINERY:

In the August issue of MACHINERY, under the heading "Another Power Producer," you have edited a very satisfactory article, which is most refreshing in its candor and logic, particularly after reading the purely descriptive and what we might call "say so" productions in some of the contemporary journals. It shows a discrimination against exploiting mechanical devices which are heralded by such a ridiculous series of statements as can be gleaned by an interview with the promoters of this world beater. Whatever real merit which may be present, would readily be killed off by the new engineering catechism which garnishes the pamphlet and verbal interviews. The writer was solemnly assured that a H.P. was 33,000 lbs. lifted one foot; the time evidently having no bearing in the matter. This interesting fact was brought out in answer to the inquiry "What speed does the engine run at to develop the rated power." The answer was that the speed might be anywhere from 10 to 800 r.p.m., and that it had nothing to do with the power of the engine which was 1 H.P. under all conditions. The reference in the pamphlet to the prospective use on boats was on the basis, I suppose, of taking the water from as low a point as possible and using the head resulting from the displacement of the vessel. After reading what goes before, it is a paradox why the author hesitated to dispose of the waste water by the simple method of extending the exhaust through the bottom of the boat. It might add another patent to his long list. W. H. CORBETT.

## GRINDING.

*Editor* MACHINERY:

In your issue of August, in Mr. W. H. Van Dervoort's article on "Machine Tools—Their Construction and Manipulation," in his fifth class, namely grinding, he says: "Grinding operations, although necessarily slow, make possible the accurate finish of the hardest metals."

While I take no exception to the latter part—that the hardest metal can be accurately finished—I do take exception to the statement that grinding operations are "necessarily slow." The grinding machine is only intended for finishing operations and it is much more rapid for this work than the old method of finshing, when it is well understood and a proper machine used, whether it be upon soft or hard metals, and the statement made is misleading.

In using the grinding machine for reducing work a considerable amount the statement is correct, but it should be remembered that the grinding machine was not built for this purpose.

Mr. Van Dervoort may not have intended to convey the idea that grinding is not an economical method. He may, however, have drawn his conclusions either from seeing grinding done on machines not well adapted, or the operator lacked the qualifications or knowledge necessary for the best results. But the fact is, grinding is an economical method of finishing all materials, whether hard or soft, owing to the superior work and the rapidity with which it can be accomplished. A solid machine, well built; proper emery wheels and in good condition, proper speeds of work, emery wheel and feeds; a plentiful supply of water in all cases to keep the work normal—by keeping it cool—and good judgment, which experience soon gives to the apt person, figure much in doing work rapidly, accurately and economically by grinding, which is the proper method and will ere long be universally employed for doing all kinds of commercial work, as well as the finer class, and it is rapidly becoming the general practice.

A. B. LANDIS.

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## WRINKLE IN COOLING MACHINES.

A novel application of thermodynamics to domestic purposes has recently turned up in the shape of an air-cooling apparatus for offices, apartments and habitations. It is a somewhat radical departure from previous methods in that the source of the cooling is not, as generally heretofore, the conversion of mechanical work into the abstraction of heat, either directly or indirectly, but merely depends upon the enormous latent heat of vaporization of water. Water from any convenient source is supplied in a thin film to the copper top of a flat convoluted air flue and a sharp air blast is directed axially along and over this flue from a special little blower motor. The forced evaporation chills the air-flue vigorously and drops the temperature of the whole air-blast from 10° to 20° F., according to the rate of evaporation attained. The net result of this arrangement, the details of which are here only sketched roughly, is to send out into the apartment to be cooled about 10,000 cubic feet of air per hour cooled to a temperature of about 68°, on an expenditure of about 100 watts. By adjusting the machine the air supplied can be sent out without any added moisture or with such a degree of humidity as may be desired, and the temperature may likewise be varied, although as usually adjusted the temperature of the air delivered is controlled automatically within a few degrees range. Obviously such an apparatus is not intended or adapted for cold storage work or the like, but within the range required for effective house cooling it is much more efficient than any machine which depends on the degradation of mechanical energy. The new machine is manufactured under patents to Dr. Louis Bell and is about to be placed on the market.—"Electrical World."

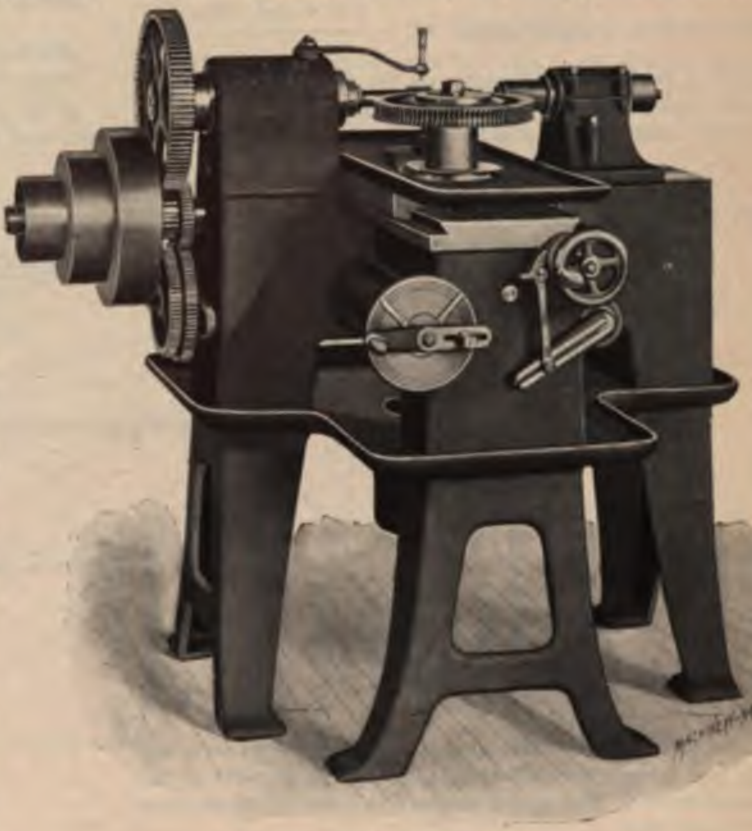
* * *

The August number of MACHINERY was the last number of Volume V. and those who wish the index for this volume will receive it upon application.

## AN AUTOMATIC WORM-WHEEL HOBBING MACHINE.

The machine illustrated in connection with this description is one recently brought out by the Grant Machine Tool Works, of Cleveland, Ohio, and is designed for automatically cutting worm-wheels from 2 to 20 inches in diameter of any pitch up to 2 inches. No previous nicking is required, as the machine will cut the wheels from the solid metal at a greatly reduced cost over the ordinary methods usually pursued.

The worm-wheel to be hobbed is mounted on a vertical spindle and is adjusted to the required height by the handwheel shown under the frame. For obtaining the correct height a micrometric device is swung over the rim of the wheel, and when adjusted to the width of the rim it forms a gauge for setting the wheel to the same height as that of the arbor carrying the hob. The sleeve carrying the work spindle has a positive movement through a worm and worm-wheel driven by change gears, which can be arranged for either right or left hand worms. The worm-wheel on the work spindle carries a cam on the side of the rim which operates the feed mechanism, having a range from zero to 1-32 inch per each rotation of the hob. The feed motion is limited by a stop, not shown, having a micrometer reading, which, being properly adjusted, stops the feed when the hob has advanced into the worm-wheel to the correct depth.



NEW WORM WHEEL HOBBING MACHINE.

An index on the shaft can be used instead of the change gears for cutting wheels of any kind which require a number of teeth or notches around the circumference. A pan is provided for catching water, oil or chips, and there is also a pan under the whole machine for the same purpose.

We are informed that a pump can be attached when wanted at an extra charge; also that the total weight of the machine when boxed for shipment is 1,750 pounds.

* * *

The "American Shipbuilder" says that it is getting to be pretty well understood that the frequent breaking of propeller shafts is not due to the defective material of the shafts themselves so much as to the excessive strains to which they are subjected, owing to the working and straining of the hull of the ship in a seaway. Careful measurements taken on a steamer in heavy weather showed that the propeller shaft was at times sprung out of line 1¾ inches in a length of 112 feet. Measurements on deck showed the same amount of deflection. The ship was stiffened, and the shafting gave no further trouble.

## PRACTICAL PROBLEMS.

### ANSWERS TO PROBLEMS 19 AND 20.

Problem 19.—The most practical method for calculating the diameters of the various steps of two cone pulleys of unequal dimensions for open belts seems to be to find the belt length required for the two given steps and to use it as the determining limit for the remaining steps. This method is perfectly logical as it is required that the steps shall be of such size that no matter what the ratio may be between them, the belt will have an equal tension on any pair.

Some readers of MACHINERY may remember an article on "Cone Pulleys and Belts" by W. L. Cheney in the issue of April, 1895, which gives some simplified formulas for determining the various sizes of the steps and on account of its simplicity we will use the one given for finding the belt length in solving this problem.

The formula is: $\text{Length of belt} = 2\,C + \frac{11\,D + 11\,d}{7} + \frac{(D - d)^2}{4\,C}$

in which C is the center distance, D the diameter of the large step and d the diameter of the small step.

The belt length for the middle steps can then be found as we know the size of the smaller step is 8" and as its ratio to the middle step of cone pulley B is as 4 is to 5, the diameter of that step must be 10". The center distance is given in the problem as 18" so we have

$$L = 36 + \frac{110 + 88}{7} + \frac{(10 - 8)^2}{72}$$

Clearing the equation results in the belt length being 64.341", and we can use this length in the same formula to determine the remaining steps since the ratio that must exist between each pair of steps is established by the conditions given.

The ratio between the middle steps is to be multiplied by 1.6 to obtain the ratio for the next larger step on cone pulley B or $\frac{5}{4} \times 1\,6 = 2$. As we now have the ratio existing between these steps, we can substitute the ratio in the formula and determine not only the relative sizes of the pair of pulleys but also the actual diameter of one and from that the diameter of the other step.

Substituting the known values and expressing the value of D in values of d the formula becomes:

$$64.341 = 36 + \frac{22\,d + 11\,d}{7} + \frac{(2\,d - d)^2}{72}$$

Clearing the equation of fractions results in

$$32427.86 = 18144 + 2376\,d + 7\,d^2$$

Transposing the terms and completing the square gives

$$7\,d^2 + 2376\,d = 14283.86$$
$$d^2 + 339\,51\,d = 2040.55$$
$$d^2 + 339.51\,d + 28803 = 30843.55$$

Extracting the square root and transposing terms gives the diameter of d.

$$d + 339\,51 = 345.42$$
$$d = 5.91''$$
$$D = 5.91 \times 2 \text{ or } 11.82''$$

Having obtained the diameter of the two steps the result can be proved by the following method:

Draw the lines A D and G J, perpendicular to the center line C I, Fig. 1, and the line B H, tangent to the circles representing the respective diameters 5.91" and 11.82". The radii C B and I H drawn to the point of tangency will be perpendicular to B H. Draw the line F I parallel to B H, and the result is the right angled triangle I F C, in which the length of C I and F C is known.

$$\overline{C\,I}^2 - \overline{F\,C}^2 = \overline{F\,I}^2$$
$$C\,I = 18 \text{ and } F\,C = \tfrac{1}{2}\,(11.82 - 5.91 = 2.95$$
$$\text{Hence } 324 - \underline{8.7025} = 315.2975$$
$$\sqrt{315\,2975} = 17.75''$$
$$17.75 \times 2 = 35.58'' \text{ total length of straight belt.}$$

The length of belt encircling the pulleys is found by ascertaining what part of the circle is embraced by the belt in each case.

$$\text{Cosin angle } F\,C\,I = 17.75 + 18 = \cdot 98611$$

Angle F C I = 80° 30′

Angle A C F = 90° − 80° 30′ = 9° 30′

9° 30′ × 2 = 19°, which is to be added to 180° for the large step and subtracted from 180° for the small step.

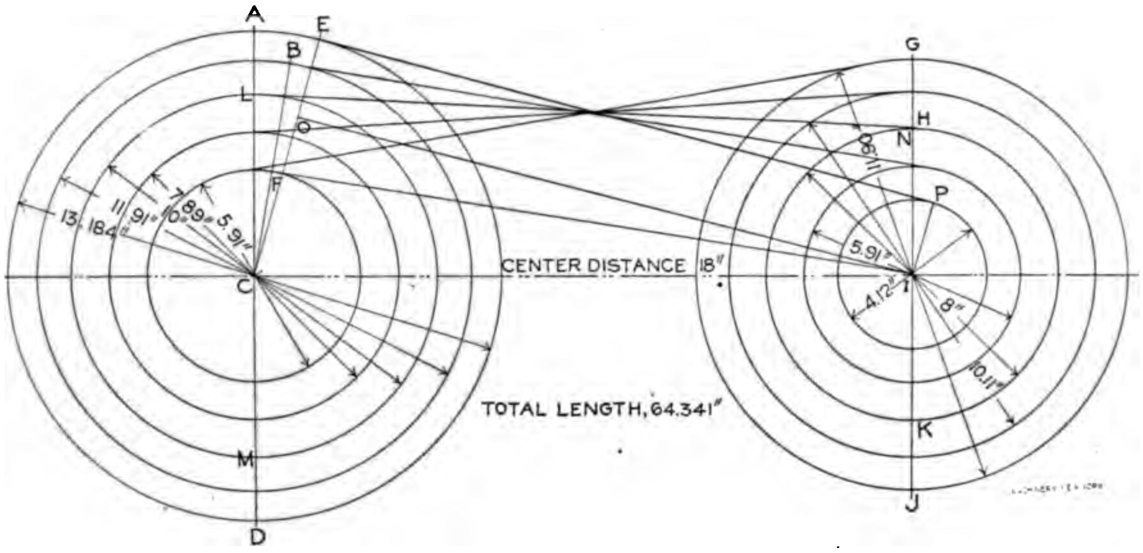


FIG. 1.

$$180^\circ + 19^\circ = 199^\circ$$
$$180^\circ - 19^\circ = 171^\circ$$
$$5\,91'' \times \frac{22}{7} \times \frac{171^\circ}{360^\circ} = 8.03''$$
$$11\,82'' \times \frac{22}{7} \times \frac{199^\circ}{360^\circ} = 20\,811''$$

3.55" + 8.03" + 20.811" = 64.341", which indicates that with the steps of the diameters given, the tension of the belt would be the same as on the middle steps.

To find the diameters of the next pair of steps we proceed in the same manner as with the first pair found.

$$64.341 = 36 + \frac{35.2\,d + 11\,d}{7} + \frac{(3.2\,d - d)^2}{72}$$
$$32427.864 = 18144 + 3326.4\,d + 33\,88\,d^2$$
$$33.88\,d^2 + 3326.4\,d = 14283.864$$
$$d^2 + 98.18\,d = 421.6$$
$$d^2 + 98.18\,d + 2409.828 = 2831.428$$
$$d = 4.12''$$
$$D = 13.184$$

It will be noted in the equation that using the value of D in terms of d necessitates the multiplication of 11 by 2 × 1.6 = 35.2 d.

The proof of the result obtained is obtained in the same manner as with the preceding case.

Drawing the line O I parallel to E P, we obtain the right angled triangle C O I, in which C I equals 18" and O C equals ½(13.184 — 4.12) = 4.53.

$$18^2 = 324$$
$$4.53^2 = 20\,52$$
$$324 - \underline{20.52} = 203\,48$$
$$\sqrt{303\,48} = 17.42''$$

$17.42 \times 2 = 34.84''$ length of straight belt.

$17.42 \div 18 = .96777$ cosin angle E C I

Angle E C I $= 75^\circ\ 30'$

Angle E C A $= 14^\circ\ 30'$

$14^\circ\ 30' \times 2 = 29^\circ$

$180^\circ + 29^\circ = 209^\circ$

$180^\circ - 29^\circ = 151^\circ$

$$4\ 12 \times \frac{22}{7} \times \frac{151}{360} = 5.43''$$

$$13.184 \times \frac{22}{7} \times \frac{209}{360} = 24.06$$

$34.84'' + 5.43'' + 24.06 = 64.33''$ or nearly $64.341''$.

Starting from the middle cone we can find the diameter of the other steps in the same manner and can prove the results as has been shown. The proof should always be made as it is a reliable check upon the accuracy of a calculation which is very likely to contain some errors.

The diameters of the steps are shown on the diagram, Fig. 1, and also in the following:

| D | d |
|---|---|
| 13.184 | 4.12 |
| 11.82 | 5.91 |
| 10.00 | 8.00 |
| 7.89 | 10.11 |
| 5.81 | 11.90 |

$$\overline{WE}^2 + \overline{WB}^2 = \overline{BE}^2$$

$W\ B = \frac{1}{2}(12.095 + 5.905) = 9'$,

Hence $\overline{WE}^2 = \overline{BE}^2 - \overline{WB}^2$ or

$\overline{WE}^2 = 324 - 81 = 243$

$W\ E = 15.59$

Cosin angle W B E $= 15.59 \div 18 = .866$

Angle W B E $= 60^\circ$

Angle A B Z $= 90^\circ - 60^\circ = 30^\circ$

Belt arc A X C $= 180^\circ + (2 \times 30^\circ) = 240$ or $\frac{2}{3}$ of the circle.

Belt arc D Y F, is the same proportional part of the circle as is readily seen by inspecting the diagram.

To find the belt length we will take the middle steps and find the lengths of the two arcs and the straight sections.

$15.59'' \times 2 = 31.18$

$10 \times 3.1416 \times \frac{2}{3} = 20.944$

$8 \times 3.1416 \times \frac{2}{3} = 16.755$

Total, $68.879''$

Suppose that the diameter of one step is 18" and the other to be zero. Then the belt length would be the same since

$18 \times 3.1416 \times \frac{2}{3} = 37.699''$

$15.59 \times 2 = 31\ 18''$

$68.879''$

This shows that any intermediate steps, the sum of whose diameter is 18" would require the same length of belt.

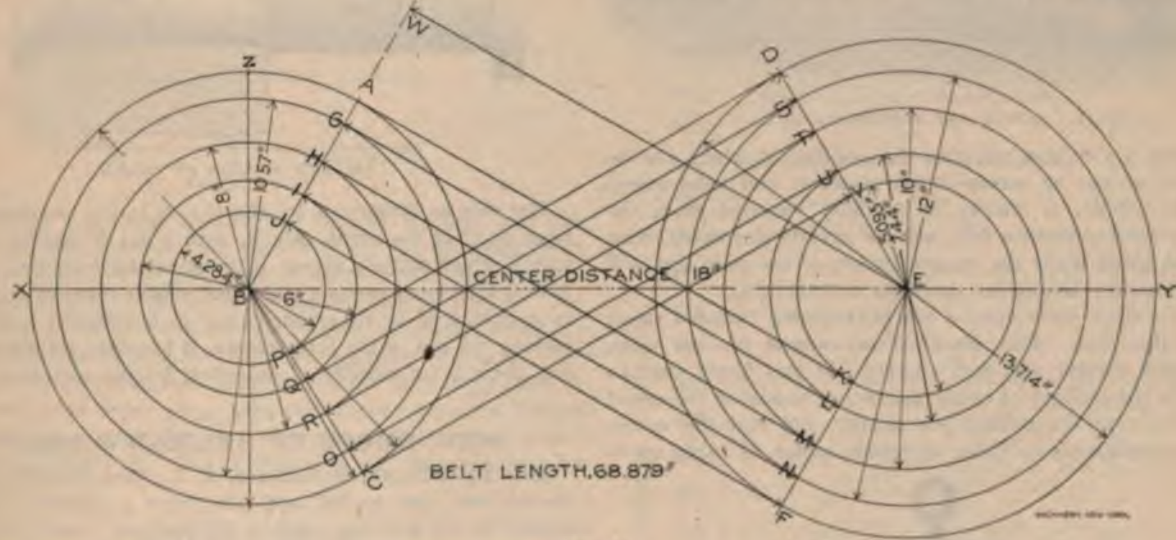


FIG. 2.

Problem 20.—The calculation for the diameters of the steps of cone pulleys intended for crossed belts is a simple matter as will be seen from a careful inspection of the diagram, Fig. 2. If the respective diameters are increased or decreased by the same amounts, the various belt lines A K, G L, H M, etc., will be parallel and the same angular portion of the pulleys will be encircled by the belt in each case. It follows from this fact that if we always keep the sum of the diameters of any two steps a constant amount, the belt will have a constant tension on any pair of steps.

An inspection of the following table of diameters will show that the sum of each pair is equal to 18" and that the multiplier used is 1.6.

| D | d |
|---|---|
| 5 905" | 12.095" |
| 7 44" | 10.57" |
| •10.00" | 8.00" |
| 12.00" | 6 00" |
| 13 714" | 4.284" |

The sizes are obtained by multiplying and dividing the diameters of the middle steps by the square root of 1.6 which equals 1.265. Thus $10 \times 1.265 = 12.65$, and 8 divided by $1.265 = 6.324$. $12.65 + 6.324 = 18.974$, but as the sum of the two steps must be 18, it is necessary to multiply each result by $\frac{18}{18.974}$ which gives 12" and 6".

The belt length required is found by extending B A to W, and drawing W E parallel to A K. Angle B W E is a right angle therefore triangle B A E is a right angled triangle.

Mr. E. T. Albenger of Philadelphia, Pa., sent an extended demonstration of this problem which we are unable to reproduce.

The department of "Practical Problems" will be discontinued on account of the time required for its proper management, but if at any time any reader wishes to propose some question of practical value, we will give it space.

* * *

The work done by steam in an engine may be likened to the effect of water on a turbine wheel. The useful work performed by the steam is accounted for by the fall in temperature, while in the case of the water it is that due to the fall of the water from the head- to the tail-race. In the case of the steam engine we are constantly reminded of the enormous loss incident to allowing the steam to escape at what is comparatively a high temperature when referred to the absolute zero, but in the case of the water-wheel no one ever thinks of complaining of the great loss of efficiency due to our inability to have the level of the tail-race located at the center of the earth. While this comparison may seem absurd there are in each case the same analogous conditions existing that render the seeming loss in the engine no more to be regretted than in the case of the turbine wheel.

* * *

It is reported that the E. P. Allis Co., of Milwaukee, Wis., the well-known engine builders, have leased the Lake Erie Engineering Works at Buffalo, N. Y., and expect to have 500 men at work there by September 1.

## VARIABLE SPEED MOTOR.

In the accompanying illustration, Fig. 1, is shown a combined portable motor and flexible shaft as now made by the Stow Manufacturing Co., Binghamton, N. Y. These outfits are made in sizes capable of drilling up to half inch for the smallest size to those that will drill a hole two inches in diameter, or do other work requiring equal capacity.

The motor shown is of a new variable speed type which will give 60 per cent. variation, and it is claimed, without loss of efficiency. The method of accomplishing this result is clearly shown in Fig. 2. The upper pole piece is hollow and the cavity is filled with a soft iron cylinder, the position of which can be adjusted in or out by means of the eye-bolt and hand-wheel. When the cylinder is wholly or partially removed from the cavity, the total magnetic flux will be greatly decreased, thus raising the speed while the magnetization of the pole tips will remain sufficiently strong for sparkless commutation.

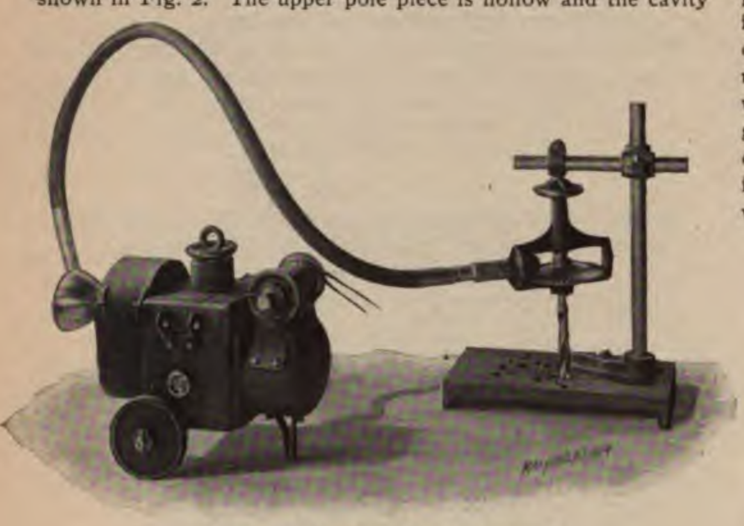


FIG. 1. MOTOR AND FLEXIBLE SHAFT.

Tests have been made upon a one horse-power inclosed shunt motor of this type. This machine was wound for 110 volts, and the field current was 0.36 ampere. It was found that an elevation of the plunger of about 2½ inches increased the speed from 830 to 1170 revolutions per minute, and that the motor would run sparklessly in either direction, under all loads up to 50 per cent. overload and at all speeds between the above limits, without changing the position of the brushes. Furthermore, while the motor was running under full load, the plunger could be suddenly lifted to its full height, thus instantly raising the speed by almost one-half, and athough the ammeter needle would momentarily register about 23 amperes, no sparks were perceptible at the brushes.

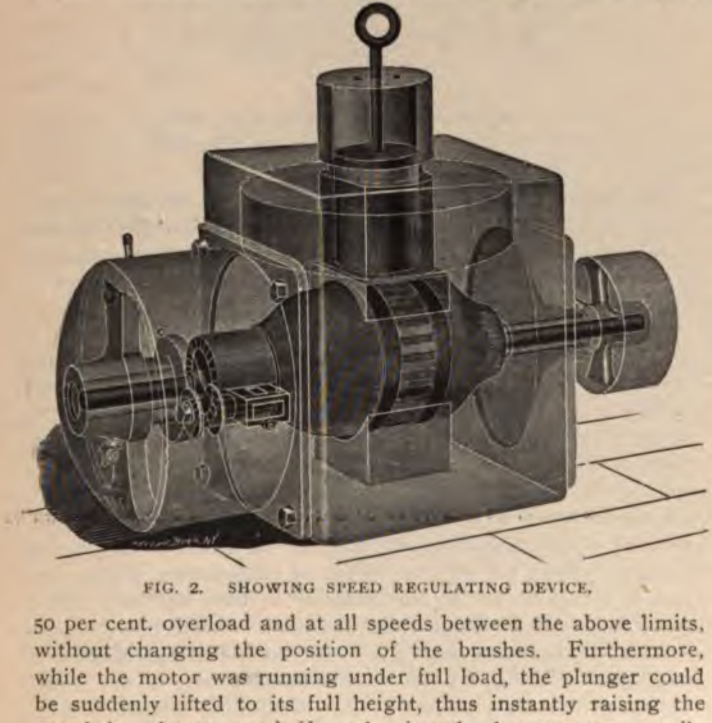


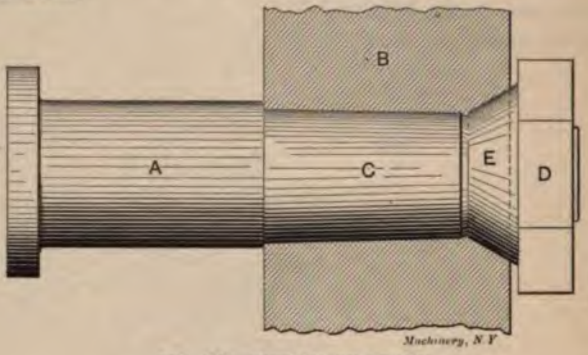
FIG. 2. SHOWING SPEED REGULATING DEVICE.

This method of speed regulation abolishes the rheostat altogether, as it is not even used as a starter. When the motor is to be used for direct connection to machine tools instead of with the flexible shaft, it will be found that the form in which it is made, with three flat sides, makes it specially adapted to the purpose. The motor is also about one-third lighter than the iron-clad type which this company has heretofore used extensively.

* * *

## A REMOVABLE CRANK-PIN.

Apropos of the method shown by Mr. Halloway in the "Shop Kinks" on another page, for trueing worn crank-pins of the ordinary riveted form, it may be of interest to note a form of crank-pin designed by Mr. Arthur of the Arthur Company, New York, for obviating the troubles incident to keeping the ordinary form of pin true. This style of pin is in use on a small Corliss engine used for driving the shop dynamo but Mr. Arthur states that he would have no hesitation in applying it to a large side crank engine and an examination of the scheme seems to call for its endorsement, as it certainly has the merit of solidity with the manifest advantage of being easily removed and turned in the lathe when worn.



PIN AND SECTION OF CRANK.

The idea as illustrated by the sketch is the combination of a taper fit C in the crank disc B, with a nut D having a tapered part E which fits in a recess of the same shape in the crank disc. A well fited taper pin is a solid and reliable form of construction as is evidenced by its extensive use in locomotive work and by making the nut of the form shown, it becomes solidly locked so that there is no liability of loosening by the vibration.

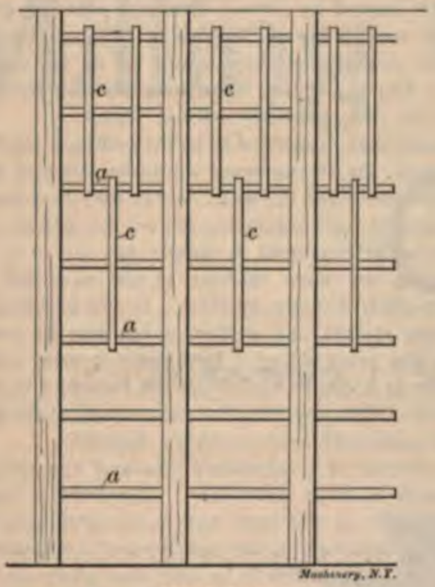
* * *

## NEW SHOPS OF BEAMAN & SMITH.

Beaman & Smith, Providence, R. I., have recently built and moved into new works, and now have a modern plant well adapted to the growing needs of the business As is well known, this firm manufactures milling and boring machines also other machine tools, many of which are of a special character. The demand for such machinery is not only increasing daily, but the tendency is toward heavier and more powerful machines to perform work that either was not done at all a few years ago or else was done on an entirely different type of machine. The new works not only afford increased capacity but provide the means for turning out machines of large size. Two boring machines of 45 tons capacity have lately been shipped and two others of similar design are now in the works.

The main building of the plant is 128 x 60 feet, with a wing 20 x 48 feet. The building is of self-sustaining steel construction with brick walls between the steel columns and there is room to add to both the end and the side of the building making it 120 by 250 feet in size. The large tools and erecting floor are served by a ten-ton Shaw electric crane and the tools throughout are driven by electric motors. These motors are distributed about the plant, a twenty H.P. motor driving the small tools, a fifteen H.P. motor the planers, a ten H.P. motor the milling and drilling machines, and even the tool room has its own drive in a three H.P. motor. One large Gray planer has its own motor. The shop is heated by the Sturtevant system of hot air, with the fan driven electrically. A convenient appliance is a three H.P. portable motor that is used to drive the machines built in the shop after they have been erected. At the time the writer called, this motor was attached to a heavy milling machine which was surfacing its own table in place.

As might be expected, a firm engaged in work of the character done by Beaman & Smith collects a great many patterns and it is important to have ample and secure storage room for them. Their building for pattern storage is 64 by 30 feet, three stories high and has several novel features. The windows are all made with one sash only and do not open, to obviate the danger from sparks coming through an open window or from rain beating upon the patterns. To secure ventilation there is an opening through the lower floor, with a screen to protect the opening which allows a current of air to pass into the building from the outside. A ventilator in the roof allows the heated air to escape. All the windows have corrugated glass which diffuses the light and keeps the direct rays of the sun from inside the building.



STOCK RACK.

A building has been erected for bicycle storage, and the lavatories and coat room are well fitted up. In the stock room the rack for the bar iron and steel is a little out of the ordinary and a section of it is shown in the accompanying sketch. The main uprights are of wood through which horizontal holes are bored for the pieces of round bar iron as shown at a, a, a. The lower part of the rack has large spaces for the larger sizes of stock, and in the upper part of the rack these spaces are divided off by vertical pieces of flat iron, through which holes are drilled for the horizontal bars. The construction will be made clear by the sketch.

* * *

## SOCIETY NOTE.

"Cornelius Vanderbilt, Jr., though a millionaire, has invented a locomotive." So says a New York daily under a startling scare heading. Reading down the column we glean the following important facts:

(Special Dispatch.)

"Newport, Aug. 16.—Cornelius Vanderbilt, Jr., has proved to be a genius, and although at odds with his father, he is the smartest member of the Vanderbilt family. He always has been of a mechanical turn of mind, and has designed a sailboat and electric launch.

"It will be news to the world to know that this young millionaire is the inventor of a locomotive, every part of which was made from designs furnished by him. The engine has been built and tests are now to begin. A special feature of the Vanderbilt locomotive is the firebox, and if it turns out as Mr. Vanderbilt expects, will be a big saving of labor and money. This particular firebox is arranged so that it can be removed, when burnt out, or for cleaning, and replaced in one night, the removal of a few bolts being all that is necessary.

"The tests will be watched with great interest, not only by the mechanical world, but by society."

* * *

## DIAGRAM OF PULLEY WEIGHTS.

Wm. Sangster,

Several years ago a friend gave the writer a list of pulleys and their weights, compiled from the records of a jobbing shop, which had installed a large number of plants for power transmission. The list gave the weights of pulleys from 6" to 42" diameter, and from 3" to 16" face, and represented an average of several years' practice, as the weights had been plotted and curves drawn through them. The writer has again plotted the weights and deduced an appropriate formula.

The curves in the accompanying diagram are seen to be a series of diverging straight lines. These lines are the result of two factors—one a constant for each diameter and the other a factor of diameter and face. The formula is somewhat complicated, but not necessarily so if one owns a table of logarithms and a slide rule.

It may readily be seen that an equation, probably varying as the square of the diameter, would give the weight of arms as a constant for each diameter of pulley, and this equation is expressed by

$$.0362\ D^2 - 2$$

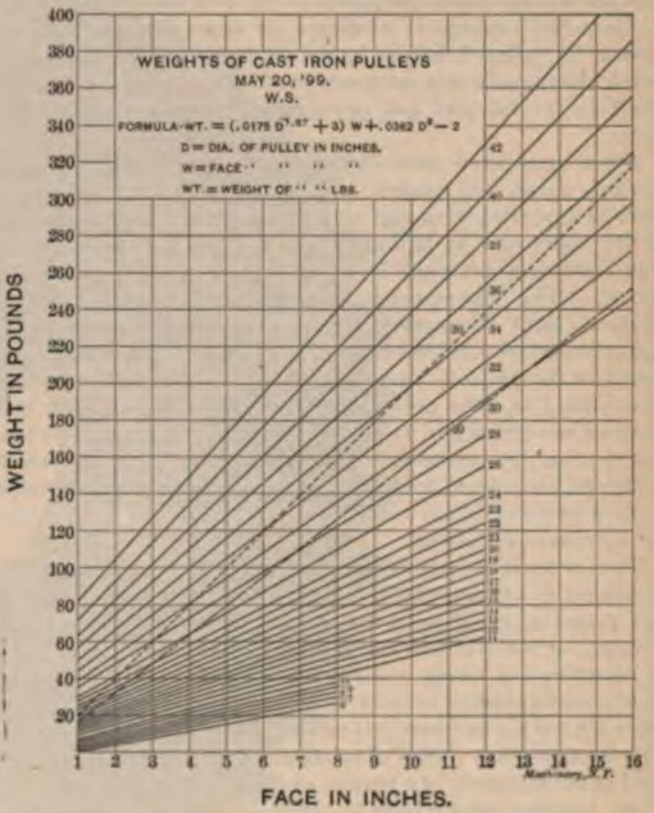
The rims on the larger pulleys are thicker than those on the smaller ones, and the equation,

$$.0175\ D^{1.87} + 3$$

gives the weight of rim for each inch of width. D in each of these equations represents the diameter of pulley in inches. The combined equations

$$.0362\ D^2 - 2 + (.0175\ D^{1.87} + 3)\ W$$

where w = face of pulleys in inches will be found to be fairly accurate for estimating pulleys from 10" to 42" diameter. Pulleys under 10" diameter easily vary 100 to 200 per cent. in weight, owing to the various sizes of shafts with their corresponding diameters of hubs. The formula is not correct in the case of a 6" × 1" pulley, which, according to the diagram, has no weight.



The perpendicular lines on the diagram represent the widths of the faces of the pulleys and the diagonals the diameters, both in inches, while the horizontals give the weights in pounds. To find the weight of a pulley look for the diagonal giving its diameter and follow along this line to the perpendicular, representing the face. The horizontal line at the point of intersection gives the required weight.

In Clarke's "Pocket Book," page 445, we have two formulas given for weights of pulleys. One for pulleys from 1 to 4 feet diameter

Weight in pounds = 7 D − 1.75 (1)

and the second for pulleys from 2 to 7 feet diameter

Weight in pounds = 11.625 D − 9.25 (2)

In both cases the formula gives the weight per inch, width of face, and D represents the diameter of pulley in feet. These formulas are represented on the diagram by a dotted line for equation (1) and a dash-and-dot line for equation (2), both for a 30" pulley.

## TO UTILIZE THE COOLING WATER OF GAS ENGINES.

Mr. O. F. Allen calls attention by an article in "The Gas Engine" to a matter of economy that is usually neglected in the operation of these motors:

While every one who has to do with gas or gasoline engines knows that they all require artificial means for cooling the cylinder, how many users of fluid fuel engines know what proportion of the total work done is expended on the water jackets, or, knowing, have sought to utilize that energy.

Several reports of exhaustive tests of engines of moderate size have come to my attention, and they show that from 20 to 50 per cent. of the heat developed by the combustion of the fuel is taken away by the water used for cooling the cylinder. There is also a large amount of heat carried off by the exhaust gases, which will not be considered here.

The temperature of the water in the packet has a great influence on the power developed. I have often gone to the valve on the water inlet of a small engine used for charging storage batteries, where the load is always the full capacity of the engine at the speed it is adjusted to, and by manipulating it slightly have changed the output over 20 per cent., with the same fuel consumption, without touching another part of the engine or dynamo. There is a certain temperature for each engine and for each load condition, at which the engine has a maximum efficiency. If the cooling water is above or below that point, the power development is decreased. I would suggest that a thermometer be placed on the inlet and outlet pipes of all fluid-fuel engines of moderate or large size, and the attendant in charge determine by the difference in temperature between the ingoing and outgoing water which gives the highest efficiency for full load and various fractional loads which often occur.

When these have been determined by trial they may be marked on a card posted near the engine, and whenever there is any marked change in load conditions the temperature of the water can be adjusted to suit. The fuel consumption would certanily be much lower and the regulation more satisfactory. The thermometers can be screwed in by the attendant; such thermometers as are used on feed water of steam boilers or on kitchen boilers in modern houses are well suited to the purpose. Assuming that an engine is fitted up so as to waste as little heat as possible on the water, there still remains something like 30 per cent. on the best engines, and 50 per cent. on the poorer ones, of the total heat developed which is thrown away—sent into the sewer or radiated from expensive cooling tanks set in the coolest place which can be found about the premises—all wasted.

Take a 50 H.P. engine, for example, which is burning the equivalent of a thousand feet of city gas an hour: who would buy five thousand feet of gas a day and burn it out of the top of the chimney, or use it to heat the back yard of a factory? You say it is necessary? I admit it is necessary to draw that amount of heat from the engine cylinder by means of the water jacket, but there are few places where it is necessary to waste all that heat. I will mention a few classes of installations where the heat may be used to advantage all or a portion of the year to reduce other fuel bills. I cannot call attention to nearly all uses, but suggest these as typical.

Frist, small engines in dwelling-houses for pumping water or driving dynamos. In every house which can afford a pumping engine there is a domestic hot-water boiler. It is now customary to connect one boiler to both a gas and a coal range. As the temperature of the water-jacket is equal to or above that which usually prevails in a kitchen boiler, why not connect it also and let it help supply the hot water for the house, thus saving coal in winter and gas in summer. The previously wasted heat is thus made available all the year.

If a gasoline engine is used about large stables where warm water is required for mixing food for animals, let the circulating tank be supplied with a ball-cock to keep it full, and put a faucet near the outlet of the water-jacket, from which to draw the required hot water. In factories and institutions hot water has many uses—in the wash rooms, for instance; and for a dozen and one purposes, in fact, which will occur to each reader according as he is interested. By the arrangement of a tank automatically kept full, warm water may be drawn near where it leaves the engine and made use of. Gas engines are beginning to be used in laundries. Heat is required in the drying-rooms. They can be piped for heating by hot-water circulation, and at least a portion of the work formerly done by steam be performed by the gas engine.

The larger engines may be divided into three classes: Engines in pumping plants, engines in large buildings for operating electric plants, and engines for operating the electric department of combined gas and electric-light companies. Many pumping plants have small buildings devoted to their exclusive use, which are heated by stoves, furnaces, or other devices. At comparatively small expense, hot-water radiators could be connected to the engines as they would be to an ordinary hot-water heater, and the wasted heat thus take the place of a portion of all of the fuel commonly used in winter.

With a supply tank connected as to the ordinary dwelling-house hot-water heater, the arrangement would be safe and efficient. In office or public buildings the water jacket may be connected to a special radiator in the basement, where the engine usually is, this radiator to be arranged to supply hot air to a portion of the building in the same manner as the so-called "indirect" steam or hot-water heating systems. If the building is heated by a hot-water system, the engine jacket may be connected to a heater on the principle of a feed-water heater, and partially heat the water as it comes back from the radiators to the regular heater. With either method the heat thus utilized effects a positive and considerable saving in the fuel bill.

Near the station of a combined gas and electric-light plant there is usually a large gasholder. In northern parts of the country the water in the tank has to be artificially heated in winter. Such a tank makes the best kind of circulating tank for a gas engine. Connected to it by only two pipes—in occasional instances with a small circulating pump in circuit—the great body of water forms a reservoir, which is very slow to change its temperature, and therefore the valves on the water-jacket would require little attention. The heat developd would in many cases be sufficient to keep the holder-tank from freezing. Gas companies seeking to introduce large gas engines do not seem to have considered these uses to which a portion of the energy of the gas may be applied, either at their own or their customers' premises.

While only a few means for saving the heat of cylinder cooling water have been mentioned, there are so many others that probably nine fuel plants out of ten of over 5 H.P. could find profitable uses to which the surplus heat might be applied during all or a portion of the year. There are few places where there is a gas or gasoline engine of any considerable size where there is not a demand for heat between normal and 140° F. The application of a thermostat for regulating the supply of water to engine jackets is worthy of investigation, and I hope soon to try some experiments with a view of determining the advantages, if any, of such a device on the water outlet pipe.

As the number of fluid-fuel engines in use increases, more attention will be paid to this matter, and it does not seem extravagant to predict that in 50 per cent. of the first-class installations of 30 H.P. and over at least 10 to 15 per cent. of the total fuel consumed will be utilized as a heat by product, thus reducing the cost of power considerably.

* * *

In a recent issue of the "Mining and Scientific Press" a writer says, in speaking of the various mines which he has visited, that those concerns conducted on such conservative lines that the "No Admittance" sign is in evidence all over the place, have back of this policy a fear of criticism rather than that some visitor may learn secrets which may prove to his advantage elsewhere.

Can it be possible that there is something akin to this condition of affairs in many of the machine shops that have the signs "Keep Out," "Visitors Not Allowed," and others of equally depressing character prominently displayed?

* * *

A hot bearing in the dusting machine of a paper mill near Sheffield, England, caused a fire, resulting in damage to the extent of nearly $125,000. It is obvious that the oiling of machinery, especially that running at high speed, cannot be too carefully attended to.

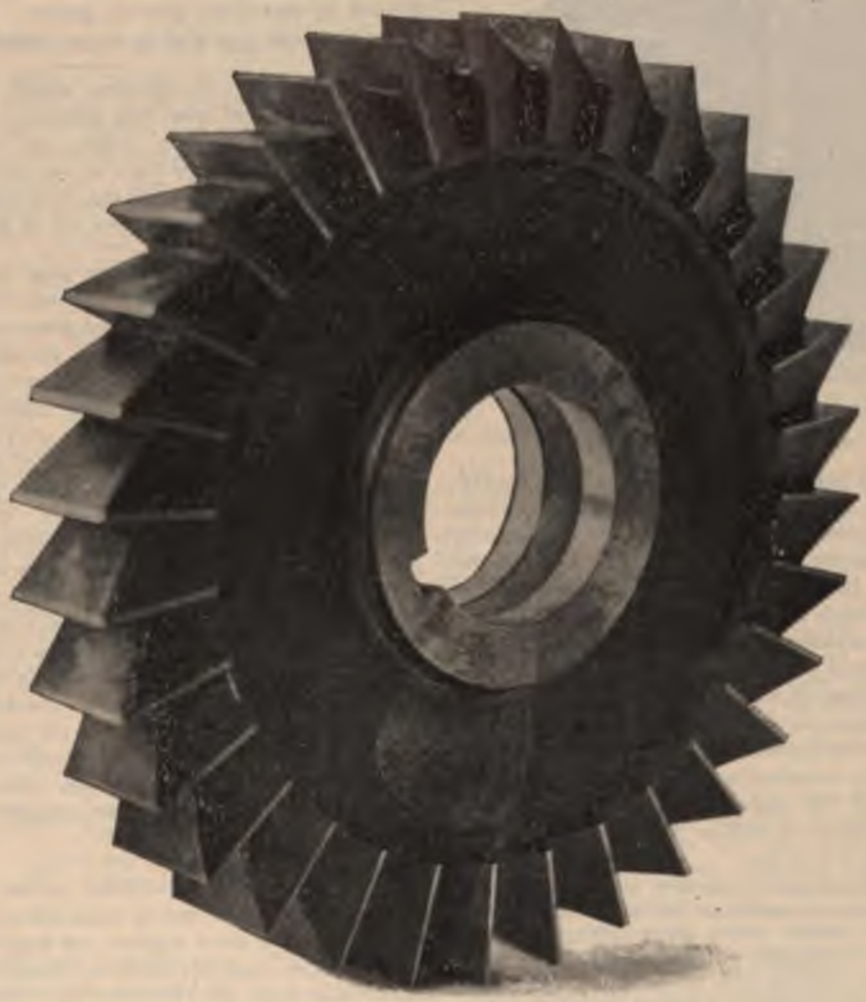
*Brown & Sharpe Manufacturing Company,*

*Providence, Rhode Island, U. S. A.*

Milling Cutters,

Gear Cutters.

36 Varieties. 3,500 Sizes Usually Carried in Stock.



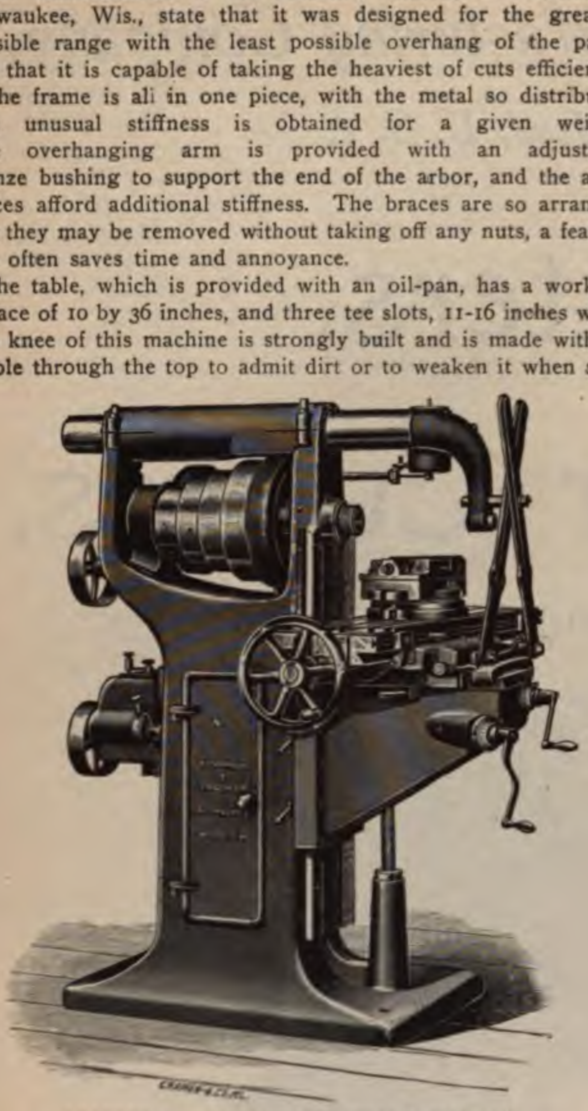
We are prepared to furnish Special Cutters of any desired Shape or Size. Our Catalogue can be obtained through the trade, or we will mail it to any address upon application. It Contains Full Lists of Cutters.

## A PLAIN MILLING MACHINE.

The manufacturers of this machine, Kearney & Trecker, of Milwaukee, Wis., state that it was designed for the greatest possible range with the least possible overhang of the parts, and that it is capable of taking the heaviest of cuts efficiently.

The frame is all in one piece, with the metal so distributed that unusual stiffness is obtained for a given weight. The overhanging arm is provided with an adjustable bronze bushing to support the end of the arbor, and the arm-braces afford additional stiffness. The braces are so arranged that they may be removed without taking off any nuts, a feature that often saves time and annoyance.

The table, which is provided with an oil-pan, has a working surface of 10 by 36 inches, and three tee slots, 11-16 inches wide. The knee of this machine is strongly built and is made without a hole through the top to admit dirt or to weaken it when subjected to side strains, and has a vertical movement of 20 inches.



KEARNEY & TRECKER PLAIN MILLING MACHINE

A special feature of the machine is the feed mechanism, which is automatic in either direction for the table, and can be thrown in or reversed by the same handle on the front of the machine. The feed can be tripped either automatically or by hand as easily when working with a full cut as when operating light, and also has the valuable feature of being changed from .006 inch to .13 inch without shifting a belt or changing a gear. Ball bearings take the thrust of the elevating and table screws, thus reducing the friction to a minimum, and all adjustments are indicated on the dials in thousandths of an inch.

Stiffness and simplicity, together with ease of manipulation, characterize the tool, and will undoubtedly result in giving it attention in shops that require a milling machine of this class.

* * *

The usual method of weighing locomotives is to first run the locomotive upon the scales and ascertain the total weight; then take the weight with the driving wheels alone resting upon the scales, and finally obtain the weight with only the forward truck upon the scale platform. While this method may generally answer the requirements of practical work, it manifestly does not give results with that degree of exactness that one likes to attain in engineering work. Accordingly, the Baldwin Locomotive Works have fitted up a series of separate scales, one for each pair of drivers and truck wheels, and the exact load upon each wheel and the total weight of the engine can be determined with precision.

* * *

It has been said that a rolling stone gathers no moss, but the machinist who sticks to the same shop through the best years of his life is likely to gather more moss than experience. The best way to gain experience and self-confidence after having served an apprenticeship is to strike out and see how work is done in other shops.

## HOW AND WHY.

### A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

**Give all details and name and address. The latter are for our own convenience and will not be published.**

1.—P. L. H. writes: Will you kindly tell me how to figure the power required to operate a vertical steam hammer. A. We are at a loss to know just what you mean, since the only power used is the heat energy of the steam, and there is no means of determining this. If the hammer falls by gravity alone the available energy is equal to the height of the fall in feet by the weight of the hammer in pounds, and this would be the amount of work required to return the hammer to its original position. If the hammer receives an impulse from the steam, however, the velocity of fall must be estimated, and the formula $\frac{W V^2}{64.4}$ used, where W is the weight in pounds and V the velocity in feet per second. The velocity of a body falling by gravity, simply $= \sqrt{64.4 \times \text{height}}$. This calculation will give the work done by the hammer, and from it must be subtracted the work done by the hammer in falling by gravity to find the work done by the steam on the down stroke. The work done by the steam on the up stroke would be the same as before, or $W \times H$. Having found the work done by the steam in one stroke, the total work in one minute can be found and this divided by 33,000 will give the power. If this answer does not cover the point you wish to know, please write again.

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2.—An English correspondent writes: My practice in keying pulleys is different from the ordinary. I cut the keyway between the arms. Where would you cut it, and why? A. We would cut it at the base of one of the arms, because that is the point where there is the most metal, and it would thus weaken the hub the least when cut at that point.

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3.—W. M. writes: 1.—Please give me some simple method for computing the gearing on compound geared lathes. 2.—How do lathe and tool builders plane the square part of boxes for lathe bearings? 3.—How is the ratio 8 to 1 obtained in the letter contributed to the last issue upon "Some Examples in Manual Training"? A. 1. See Prof. Van Dervoort's article in this issue. 2.—It is cheaper to mill the boxes than it is to plane them. There are two methods of machining them, both in common use. One is to bore them first, leaving enough to finish and face off where they join together. They can then be held on an arbor in a special fixture for milling, and finally bored and reamed in place in the head stock. The other way is to finish the entire outside first and then bore and ream in place. The method will depend partly upon whether any turning is to be done in finishing the box. 3.—The ratio of a train of wheels is found by first multiplying together the diameters of the drivers; then multiplying together the diameters of the driven wheels, and finally dividing the former product by the latter. Thus in the train mentioned the diameters of the drivers are 6, 8 and 5 inches, and their product $= 6 \times 8 \times 5 = 240$. The product of the driven wheels $= 8 \times 12 \times 20 = 1{,}920$. $240 \div 1920 = \frac{1}{8}$ when reduced to lowest terms.

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4.—W. D. writes: 1.—Please tell me what books would be necessary to enable me to take out an engineer's license. I have run two or three engines, but would like to be able to take out a license, and not knowing enough about engines, fear I could not pass the examination. Can you make a suggestion for a screen for a stack? We tried one screen that was simply fastened over the top of the stack, as in Fig. 1, but the meshes were too fine and filled up. Then we tried one with half-inch meshes, arranged as in Fig. 2. This does not arrest the sparks, however, and one day the roof caught fire. A. You probably will not be able to obtain a license by simply studying books. An important requisite is good judgment, which can come only with experience, and a knowledge of steam machinery, which you say you lack. Books, however, will help you, and we should advise you first to get a copy of Hemenway's Catechism of the Steam Plant, and after you have mastered that, take up Low's Catechism. The first costs 50

Wrong Paging

cents, and the second $2.00, both of which we can furnish. A year's subscription to "Steam Engineering," which is advertised in this number, would also be of great benefit to you. 2.—For the stack, use a screen with 5-16 meshes and have it arranged as shown in Fig. 3. Having the screen of larger diameter than the stack allows sufficient opening in case some of the meshes become closed; and the enlargement also has the tendency to check the velocity of the gases, thus forming a sort of settling chamber for the cinders. If you exhaust into the stack you will probably have trouble through corrosion and also through the meshes filling up, whatever the arrangement. In that case the screen should be placed at the bottom of the stack below the exhaust, and, if possible, at a point where the flue is of larger area than that of the stack.

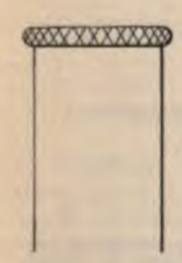


FIG. 1.

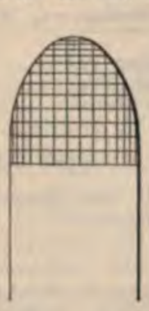


FIG. 2.

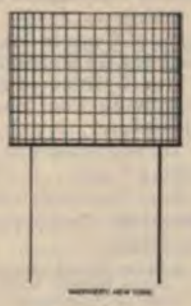


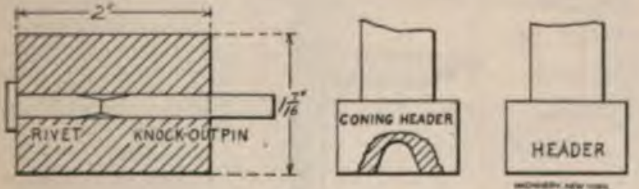
FIG. 3.

5.—J. S. H. asks: 1.—What is the standard taper for different sizes of gas pipe? Also, what is the size at the top and bottom of the thread at the small end of the pipe? 2.—You published a table some time ago on running and press fits, but did not mention shrink fits. How much should be allowed for that class of work? 3.—Please give me a rule for proportioning the dies that press the heads and points of rivets. 4.—How can I calculate how large to turn a piece of work to have it square up at a given size? A. 1.—The taper for all sizes of pipe is ¾" to the foot, total taper. The sizes wished are as follows:

| Diameter Pipe | ⅛ | ¼ | ⅜ | ½ | ¾ | 1 | 1¼ |
|---|---|---|---|---|---|---|---|
| Top Thread | .393 | .522 | .656 | .815 | 1.025 | 1.283 | 1.627 |
| Bottom Thread | .334 | .433 | .567 | .701 | .911 | 1.144 | 1.488 |

| Diameter Pipe | 1½ | 2 | 2½ | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Top Thread | 1.866 | 2.339 | 2.82 | 3.441 | 4.435 | 5.491 | 6.546 |
| Bottom Thread | 1.727 | 2.2 | 2.62 | 3.241 | 4.235 | 5.291 | 6.346 |

2.—Mechanics generally allow a little more for shrink than for press fits. About 1¼ thousandths per inch will do above 12 inches; between 6 and 12 inches, allow 1½ thousandths per inch; between 3 and 6 inches, 2 thousandths per inch, and for one and two inch shafts the same as for a 3-inch shaft. This is under the supposition that the hub is strong enough to stand the strain. 3.—This question was referred to J. L. Lucas, Providence, R. I., who replies as follows: "The size of a rivet die is governed by the machine in which it is used. It is usually about 1 7-16 inches diameter and 2 inches long. The head is first coned and then flattened, and removed by the knock-out pin, as shown by the sketch. Draw temper of die to a dark straw." 4.—Multiply the short diameter of the square by 1.414 for the long diameter, which is also the required diameter of the round stock.



RIVET DIES.

* * *

The "Western Electrician" says that experiments in the ether-wave system of transmitting electricity were conducted at Newbury, England, recently. A small powder magazine, located 400 yards from the sending point, was electrically exploded without the use of wires. The experiments demonstrated the feasibility of using the system for destroying mines, etc., in war.

## FRESH FROM THE PRESS.

A Practical Course in Mechanical Drawing, by William Fox and Charles W. Thomas, both of the College of New York, contains nearly one hundred 12mo pages, illustrated by many engravings. Published by the D. Van Nostrand Company, New York. Price, $1.25.

The authors have endeavored to present a work that will be adapted to wants of high schools, schools for apprentices and young mechanics, and have abandoned the time-honored method of presenting the geometrical demonstrations first, but have, instead, commenced with working drawings, as it is argued that the average student can grasp the idea of a concrete object much easier than a geometrical proposition. After the student is able to understand the principles of delineation, it is thought that he can more readily grasp the principles and applications of geometry, and will be inspired with a healthful desire to give this subject the study which it merits.

An excellent feature of this book is the reproduction of photographs showing the correct handling of instruments, a point that is the source of much trouble to most beginners.

The most striking feature of "The Century" for September, which will be a Salt-Water Number, is the first installment of Captain Joshua Slocum's "Sailing Alone Around the World." This is the narrative of a daring voyage of circumnavigation, undertaken by the author in 1895, in a forty-foot sloop built by himself in Buzzard's Bay, and taken back and forth across the Atlantic and thence around Cape Horn and the Cape of Good Hope without assistance or companionship. The distance traversed was 46,000 miles, and the accuracy of the navigator's landfalls throughout was a thing to marvel at, his chronometer for most of the time being a little tin clock of the cheapest kind. Captain Slocum was a thoroughly seasoned sailor when he started on his adventurous single-handed cruise, but his unique achievement was not without difficulties and perils that taxed to his utmost his strength, endurance and ingenuity.

We have received an illustrated catalogue of five hundred pages from the F. W. Gesswein Company, 39 John street, New York, entitled "Worth Looking Into." An examination of it seems to confirm the use of the title, as it appears to be worthy of its somewhat novel name, being a very complete list of metal workers' tools and supplies. Aside from its value as a buyers' directory, it contains a number of tables, of much value to the mechanic, especially some that have been calculated for the comparative weights of aluminum, wrought iron, brass and copper wire and plates, Brown & Sharp gauge.

We have received from the Bullock Electric Mfg. Company, Cincinnati, O., their latest bulletin, No. 7934, describing the Bullock engine-type generator. It explains the construction of the generator minutely, gives a detailed sheet of dimensions, and illustrates the generator direct connected to a Nash gas engine.

The Aermotor Company, Chicago, Ill., have issued their eleventh annual catalogue of windmills and pumps, which affords entertaining and instructive reading. The details of the apparatus are shown by artistic half-tone illustrations mingled with the text, and some of the possibilities of the motor are illustrated in a novel manner.

We have received a prospectus for 1899 of the work planned by the International Committee of the Y. M. C. A.. This contains a syllabus of the various courses, with sample examination papers. Two other circulars are also issued, one of which gives the annual report, and the other contains illustrations and descriptions of the exhibits made at the twenty-third international convention, held at Grand Rapids, Mich., last May.

The Pearson Machine Co., 39 West Randolph street, Chicago. Catalogue of machine tools and automatic machinery. This catalogue not only contains descriptions with illustrations of the various machines, but has several detailed sketches that are of interest. Several small sizes of screw machines and turret lathes are shown, as well as a large size for bicycle hubs and similar work. Other machines listed are a lathe designed for facing, a cock grinder, a double turret machine, a horizontal boring and drilling machine of novel construction, and several miscellaneous machines and hangers. The book also contains a table of cutting speeds for turret lathes.

The Joseph Dixon Crucible Co., Jersey City, N. J., have issued an elaborate catalogue, with an artistic cover, containing a full list and description of their various graphite productions. It will not be necessary to list the articles made by this company since they are already familiar to our readers. The catalogue is one that every mechanic should have, and we presume will be sent upon application.

E. G. Smith, Columbia, Pa., manufacturer of measuring instruments for mechanics, has issued a little booklet describing a line of sliding calipers with vernier graduation reading in millimeters, metric micrometers, speriometers and scales. It will be sent to any address.

## MANUFACTURERS' NOTES.

The L. S. Starrett Co., Athol, Mass., announce that their cutter department has been sold to F. J. Gay and E. T. Ward, who will continue with this line of goods under the name of Gay & Ward. Mr. Gay was formerly of the L. S. Starrett Co. and had charge of their cutter department.

The Diamond Machine Co., Providence, R. I., write us that Mr. John W. Cole has terminated his connection with that company.

Schuchardt & Schutte, Berlin, Germany, state that their Mr. Crause sailed on August 22 for America, and that any mail for him can be addressed care of Schuchardt & Schutte, 122 Liberty street, New York.

The Frank Mossberg Company, manufacturers of sheet metal novelties, Attleboro, Mass, are now erecting a factory which will have a floor space of over 20,000 square feet. They expect to have it completed by October 1st, and will equip the factory with punching presses, polishing machinery, and light machine tools.

Mr. Julius Herlitschka, manager of the Vienna branch of White, Child & Beney was expected to sail for this country on August 27 to open new business connections, and also attend the Philadelphia Export Congress as a delegate of the Vienna Chamber of Commerce.

De Fries & Co., Berlin, announce that their firm has been reorganized into a stock company, with a paid capital of $360,000.

The Westinghouse Brake Co. announce that after the Russian Government determined to apply air-brakes to the freight trains upon the state railways, an imperial decree was issued announcing that the Westinghouse air brake had been adopted and must be purchased by all roads, private and state. This means the production of air-brake apparatus for 350 locomotives and tenders and 11,750 freight cars during each month for the next three and a half years, the total purchase amounting to from $12,000,000 to $15,000,000.

Who can calculate the amount of money earning time wasted every day in the shops of the land through stopping to take up belts because they are slipping. If a belt did not slip it would be unnecessary to take it up—until the sides touched—and there would be besides relief of strain on belt and bearings, more belt surface producing friction on pulley face, and hence more power. The Cling-Surface Mfg. Co., of 153-159 Virginia street, Buffalo, N. Y., report they have thousands of belts fulfilling these conditions through the use of Cling-Surface. The Journal Printing Company, of Muscatine, Ia., writes: "We have been using your Cling-Surface on our belts for the past two months and unhesitatingly pronounce it an ideal article. We are able to run our machinery now with ease and accuracy that formerly was very imperfect because of belts slipping. We now transmit our power a long distance by belts that are slack, and can start up heavy machinery with ease where before it had to be lifted over by hand. Cling-Surface is all and more than is claimed for it, and we can most heartily recommend its use to all who drive machinery by belting. Our belts were never in better shape. Cling-Surface did it."

FOR SALE.—One of the best located jobbing foundry and machine shops in the Mississippi valley. Good trade established. Satisfactory reasons for selling. Address Box 554, Galesburg, Ill.

FOR DELIVERY SEPTEMBER FIRST, a large variety of second hand lathes, planers, drills, etc., in good order. For list and particulars address JOHN A. CROSS, P. O. Box 218, Providence, R. I.

FOR SALE CHEAP, ONE SEVEN INCH AMERICAN STOKER, made by American Stoker Co. of New York. In good order Apply to W. AMES & Co., Jersey City, N. J.

WANTED.—Copies of MACHINERY for January, 1899, in good condition. for which we will pay ten cents each. Mail these to MACHINERY, 9-15 Murray street, with the name of the sender on the wrapper.

PATENT RIGHT FOR SALE.—The British patent right on a valuable machine tool favorably known and thoroughly introduced throughout the United States. For full particulars please address "MACHINE TOOL," care of MACHINERY, 9-15 Murray Street, New York.

WANTED.—By a large manufacturing company, an experienced mechanical engineer familiar with construction and erection of factory buildings. State age and experience. Address E. W. C., care of MACHINERY, 9-15 Murray St., New York.

WANTED.—Competent machinist as assistant superintendent in a factory near Philadelphia, to oversee toolmakers and make estimates on light contract work. State age, experience and wages required. Address REFERENCE, care of MACHINERY, 9-15 Murray St., New York.

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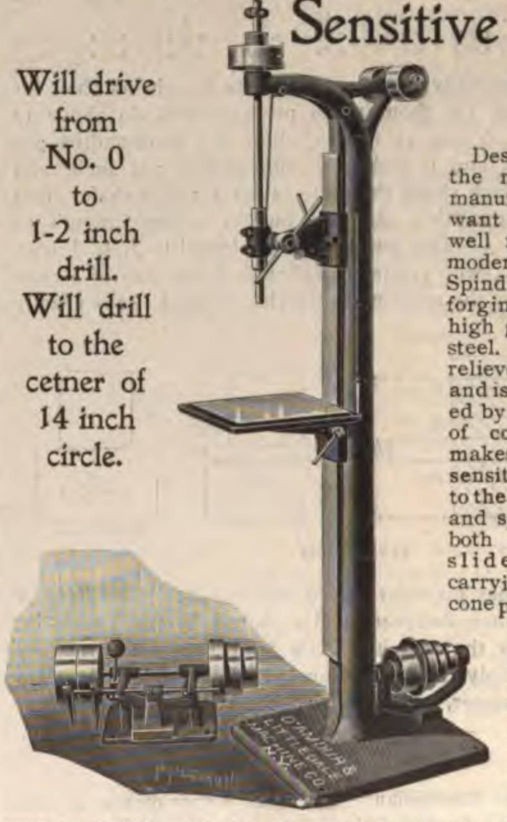
**Fresh From the Press**........ 26c

14 inch Manufacturers' Sensitive Drill No. 1.



Will drive from No. 0 to 1-2 inch drill. Will drill to the cetner of 14 inch circle.

Designed to meet the requirements of manufacturers who want a thoroughly well made tool at a moderate price. The Spindle is a special forging made from high grade spindle steel. It is entirely relieved of belt strain and is counter-balanced by a weight inside of column which makes it extremely sensitive and uniform to the touch. The table and spindle head are both adjustable on slide. The bracket carrying the driving cone pulley is securely bolted to base of machine, thus preventing vibration of column when machine is running. A thoroughly well made and reliable overhead counter-shaft furnished with machine, and included in the price.

D'AMOUR & LITTLEDALE MACHINE CO.,
135 Worth Street, (cor. Centre Street,) New York, U. S. A.
FOREIGN AGENTS: London, C. W. Burton, Griffiths & Co. Berlin Brussels, Vienna, Schuchardt & Schutte. Budapes 'oseph Schwartz & Co

MACHINERY.

Vol. 6. October, 1899. No. 2.

# MAKING HEAVY STEEL FORGINGS.

## NOTES UPON THE PLANT AND PRODUCT OF THE BETHLEHEM STEEL COMPANY.

The Bethlehem Steel Company, South Bethlehem, Pa., is known as one of the largest and most important steel plants in the world. We doubt, however, whether those who have not followed the course of events in the production of steel forgings during the past few years fully appreciate the unique and singularly distinctive part which this company have played in recent industrial progress.

In 1886 the Bethlehem Steel Company (then the Bethlehem Iron Co.) began negotiations with Sir Joseph Whitworth & Company, of England, and the Creusot Company, of France, for the establishment at South Bethlehem of a complete plant for making forgings for armor plates, guns and the necessary marine engine parts for the navy, with the result that eventually they had the most completely equipped plant for heavy forging in the world. The Whitworth Company controlled the famous "fluid compression" process for making steel for forgings, and the Creusot works at that time led in the production of solid steel armor plate, so that the introduction into this country of the methods of these two firms was an event of no small importance.

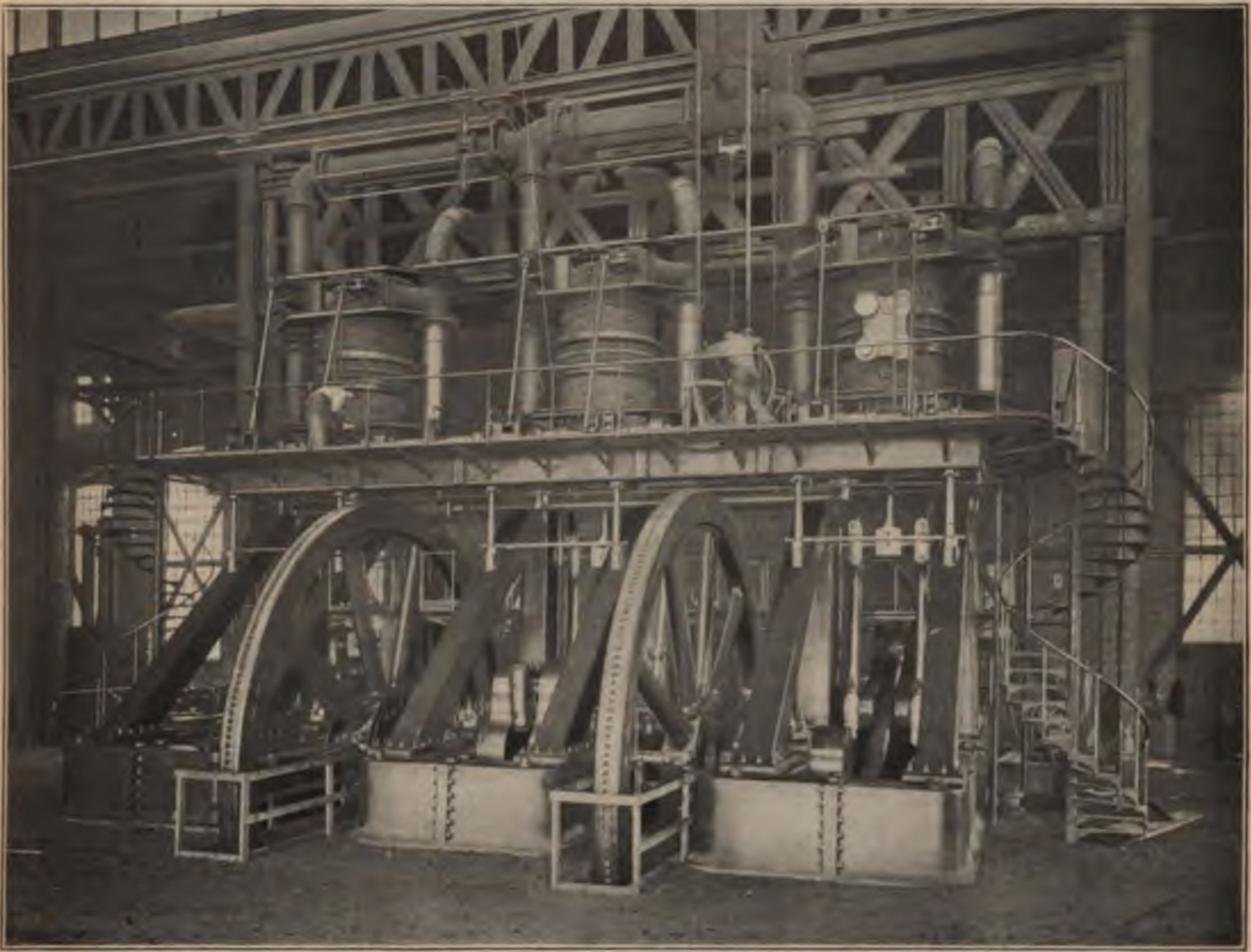


**Fig. 1.** Triple-cylinder, simple engine and pumps at the Bethlehem Works, serving the 14,000-ton forging press shown on the next page. Cylinders, 54 by 90 inches; steam pressure, 125 pounds; revolutions per minute, 60. The pumps are at the rear, have three 11-inch plungers and pump against a pressure of 7,000 pounds per square inch. This engine will develop 15,000 horse-power at about one-third cut-off and is said to be the most powerful land engine in the world. It was designed by E. D. Leavitt.

While these preparations were primarily for government orders, mainly for work upon war material, there has been a growing demand in commercial work for forgings to meet the specifications demanded by the government, and the changes that they have made possible in heavy machine construction is perhaps the most noteworthy sequence of the establishment of this plant.

Examples of this work are forgings made for the shafts of the American Line steamers St. Louis and St. Paul, 21 inches in diameter, and for the Long Island Sound steamers Pilgrim and Puritan; for the Ferris wheel shaft, which weighed 45 tons; for the field rings of the Niagara Falls generators (shown in Fig. 5); and latterly for the 4,000 horse-power engines for the Boston Elevated Railway (Fig 7), and the 8,000 horse-power units that are to be placed in the new power station of the elevated roads of New York.

The installation of engines of the size of the last named is due directly to the fact that satisfactory forgings for their immense shafts can now be obtained, and when it is realized that these forgings have a tensile strength of 80,000 pounds, an elastic limit of 50,000 pounds, and an elongation under test of 25 per cent., they become of unusual interest to the engineer. We shall later try to show the full significance of these figures, but will first recount briefly some of the salient features of the process of turning out these forgings as recently seen by the writer.

### Steel Processes.

Steel is usually defined as a compound of pure iron and carbon, although there are always other elements present, certain of which, like phosphorus and sulphur, are detrimental, and others, like the nickel in the modern "nickel steel," are beneficial in their effects. The three principal processes for making steel are the Bessemer, the crucible and the open-hearth. Bessemer steel is made by forcing a powerful blast of air through molten pig-iron in a vessel called a converter. The effect of the blast is to burn out the impurities and decarbonize the iron, after which a sufficient quantity of pure cast iron, rich in carbon, is added, to give the steel the required percentage of carbon. This steel is the standard for rails, is used to a large extent for structural materials, and is entering the market for other purposes to an increasing degree.

Crucible steel is the finest grade of cast steel, from which the best tool steels come. It is made by melting low carbon steels or bar iron in a crucible on contact with charcoal until they have absorbed the necessary amount of carbon.

Open-hearth steel is made by fusing together different ingredients, such as pig-iron and scrap steel of known qualities to give the composition wanted. The melting is done on an open hearth, enclosed only by the walls of the furnace, instead of in a crucible.

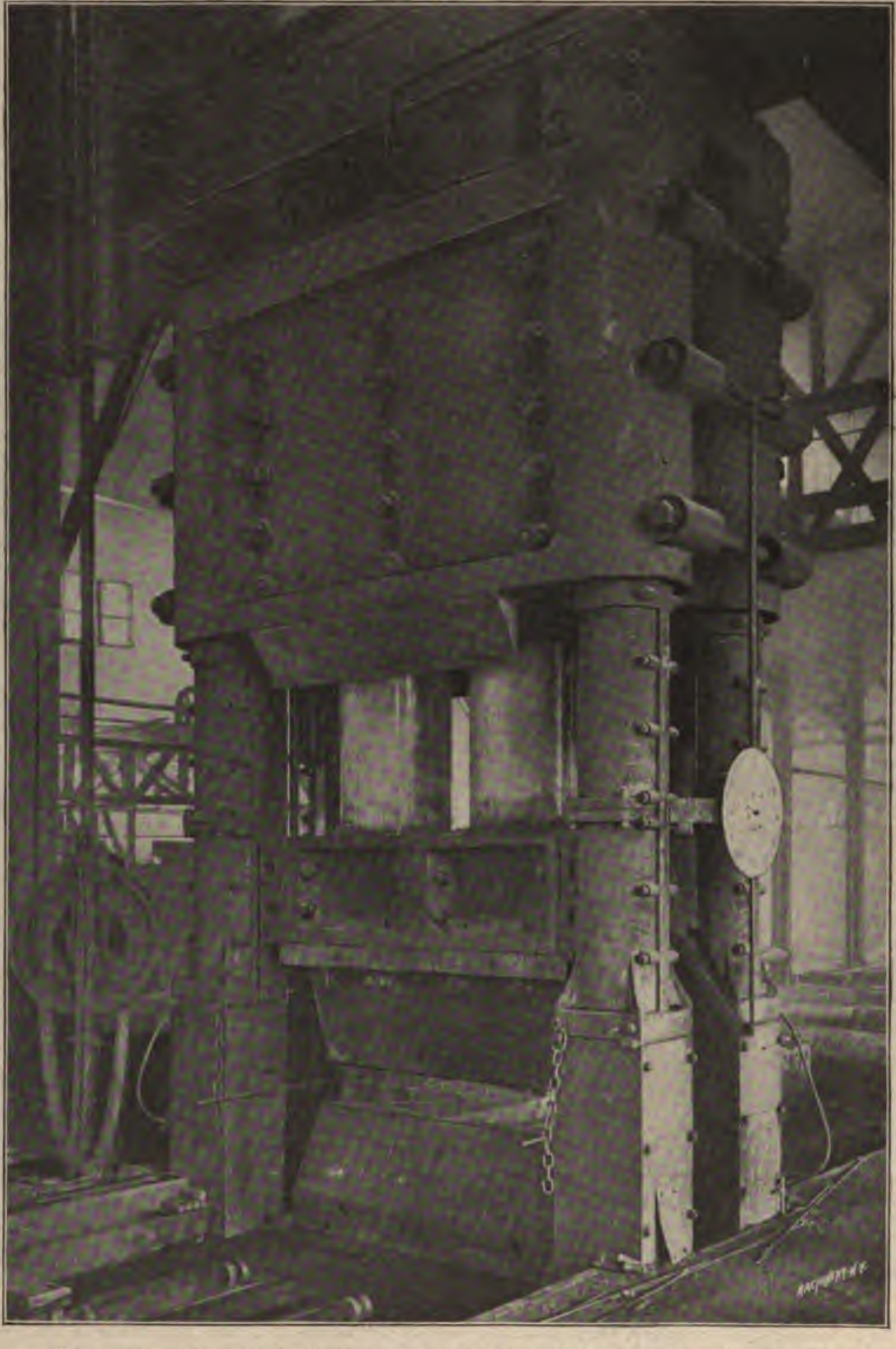


Fig 2. 14,000-ton press for forging armor plate, large shafts, etc. Diameter plungers, 50 1-2 inches; stroke, 8 1-2 feet; capacity, 14 by 17 feet On heavy work this press absorbs the full power of the 15,000 horse-power engine which serves it and at times almost stalls the engine. The engine pumps direct, no accumulator being used. Two-175 ton traveling cranes are provided for handling the forgings.

For forgings either the crucible or open-hearth steels are suitable. The crucible process is the older, and while it has been used successfully for casting large ingots, from which forgings were made, it is an expensive process and is not adapted to such work. The open-hearth process, on the other hand, enables large masses of metal to be fused without great difficulty, and is found to be well adapted for large ingots for forgings. It is even being used to a considerable extent for tool steels.

Open-hearth furnaces operate on the regenerative principle and temperatures of 3,000 to 4,000 degrees Fahr. are reached. The fuel is producer gas generated by burning coal in air-tight ovens with an insufficient supply of air fed in under pressure. The gas passes over the top of the hearth on which the melting is done, where it mingles with a separate supply of air and ignites. At each end of the furnace are fire brick passages, through one set of which the gas enters before ignition and through the other of which the products of combustion pass away. Every twenty minutes or thereabouts the direction of the current is reversed and the entering gas passes through the passages just heated by the intensely hot escaping gases, and passes out by the passage that has been cooled by the entering gas. This heating of the entering gas by the waste heat of the escaping gases is not only conducive to economy, but makes possible the extremely high temperatures produced in this form of furnace.

### The Bethlehem Plant.

At the Bethlehem steel works there are four blast furnaces for making pig-iron, and in their rolling mill there are four Bessemer converters. Their open-hearth plant has eight open-hearth furnaces, four of which are 20 tons and four of 40 tons capacity, all on the regenerative principle. In Fig. 6 is a reproduction of a photograph taken during the casting of an ingot. On the platform at the rear are ranged the open-hearth furnaces from which the metal has been drawn into the ladles.

In Fig. 4 is a large ingot of special nickel steel for an armor plate. It is shown after it has been raised from the pit, and although this is not the largest ignot that has been cast here, its

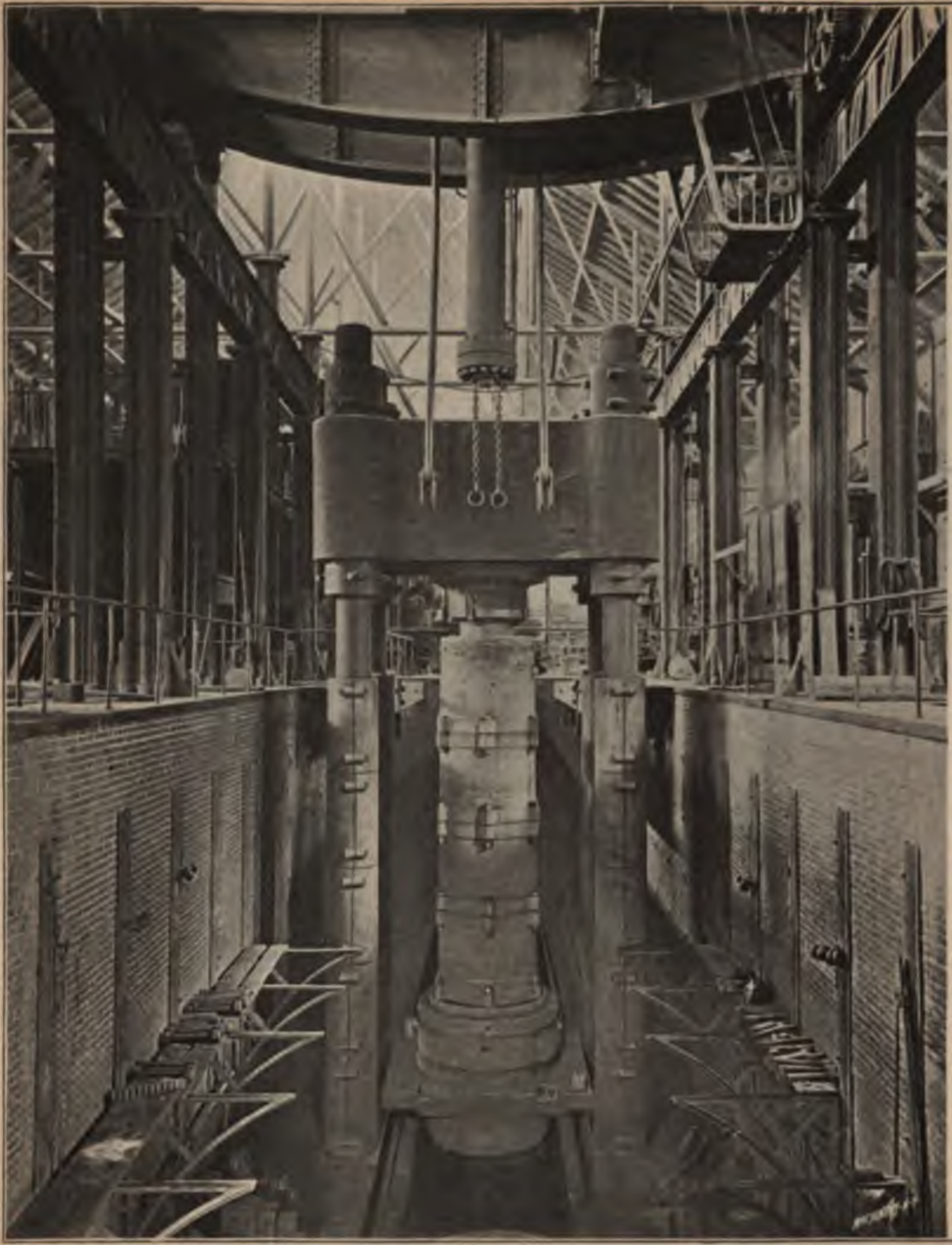


FIG. 3.

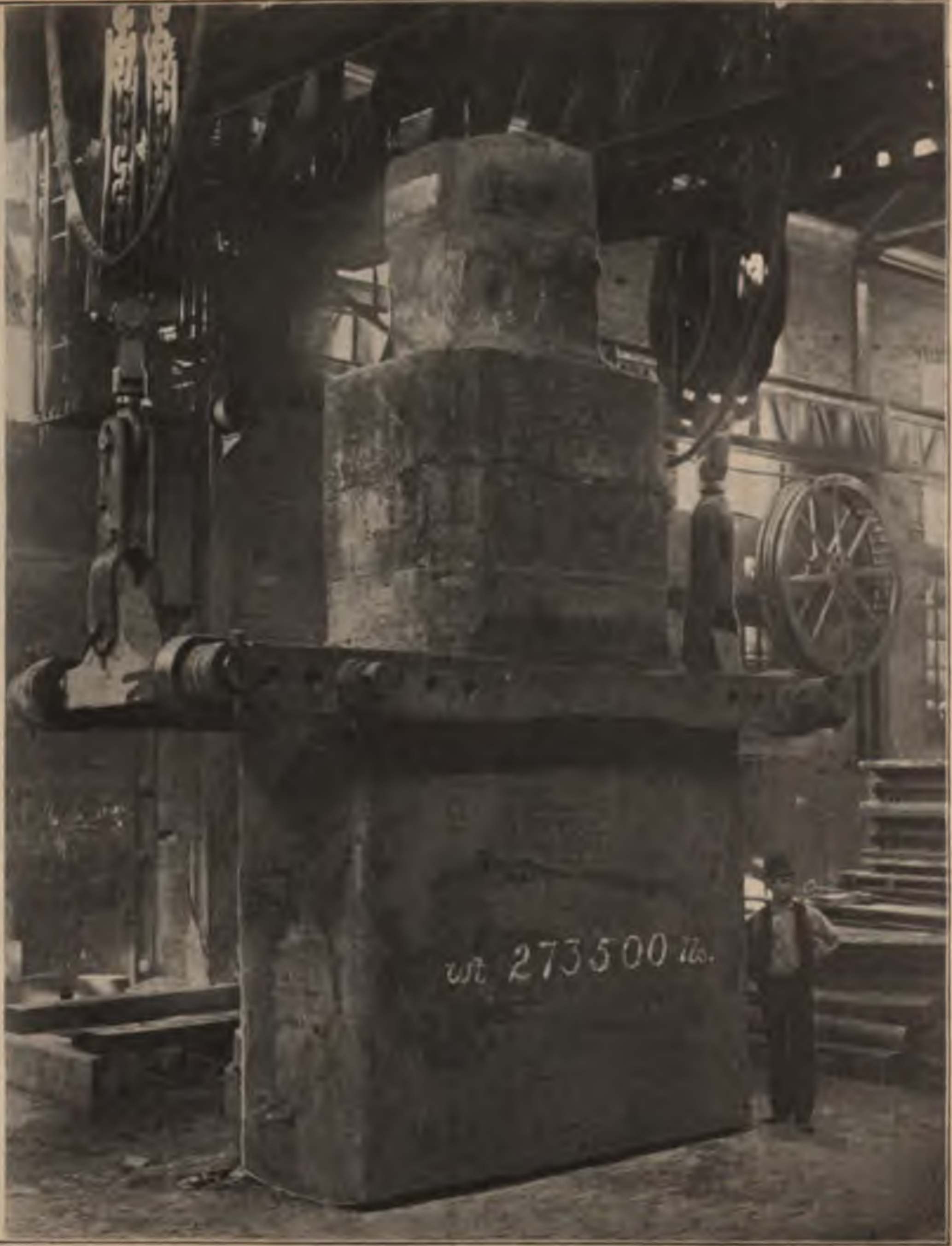


FIG. 4.

Fig. 3. Fluid compression plant. The molten steel is poured in steel molds and subjected to pressure under the press while it cools. The illustration shows a mold in position, while pressure is applied by the

weight of 122 tons and its size, compared with the man standing by its side, will give a forcible idea of the enormously heavy work that this plant is capable of casting and forging. The riser at the top of the ingot collects the impurities of the metal and also serves as a projection by which the piece can be handled in forging. This projection fits into a large sleeve or collar, cylindrical on the outside and with a square hole. The sleeve is held and rotated by the crane and the ingot is balanced by a long bar extending from the back end of the sleeve.

### The Fluid Compression Process.

In casting ingots for guns, shafts and similar work, the Whitworth fluid compression process is employed, which gives the most perfect results of any known method.

Large wrought-iron forgings are made by welding together smaller pieces of iron, building up the completed forging piece by piece. Steel does not possess the property of welding to such a degree as wrought iron, and moreover, can be cast into any necessary shape. The proper way to forge steel, therefore, is to cast ingots considerably larger than the finished product is to be and draw it out under the hammer or forging press. For the majority of work the most convenient ingot is in the shape of a cylinder, and in cooling, after it has been poured, it is found that certain defects creep in, which it is the object of the Whitworth process to eliminate.

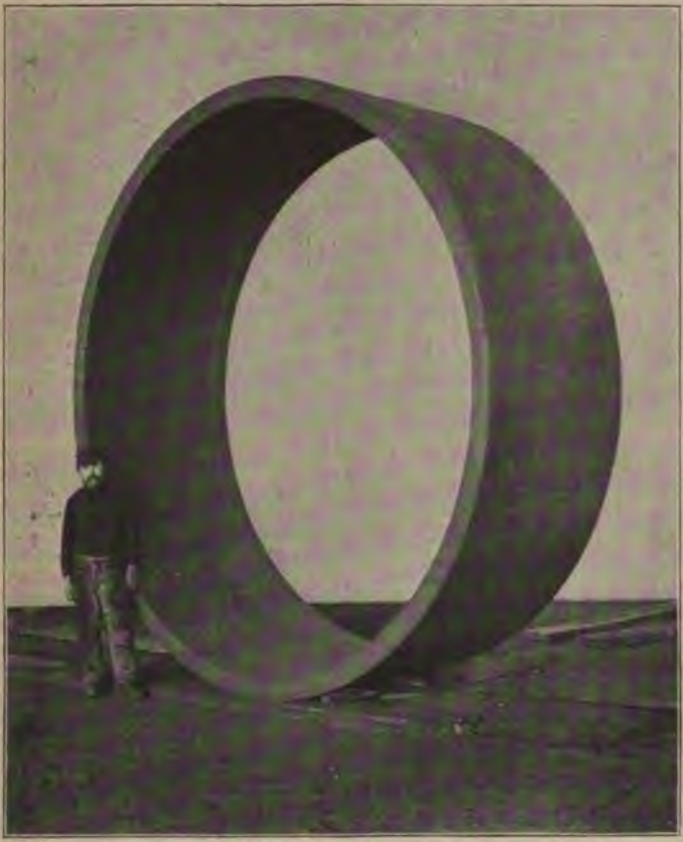


Fig. 5. Nickel steel field ring for a 5,000 horse-power generator at Niagara Falls. It was forged without a weld and weighed, after roughing out in the machine shop, 28,840 pounds. Outside diameter, 139 inches. When finished it was larger than the capacity of the furnace at that time, so that, if it had been imperfect, it would have been impossible to reheat it.

The first part to cool, of course, is the outside, and as the metal gradually cools toward the center it shrinks away from it and causes "piping" or the formation of cracks. Blow holes occur, owing to the generation of gas and the air entrapped during the pouring, which tend to make the ingot unsound. It is desirable to have these defects remedied in the ingot because the steel will not weld, and any defect at the start will be carried through to the end. Still another difficulty is that of "segregation," or the separation during cooling of the particles of which the steel is composed, owing to the different specific heats of the different elements, and hence the different lengths of time required for them to cool. The segregation is mainly at the center and near the top of the ingot, so the ingot is cast somewhat longer than required for the forging, that the upper part may be cut off and remelted.

These cylindrical ingots are poured in steel molds which are lined with cast iron staves, grooved to allow the gases to escape at the ends. Inside of the staves is a lining of some refractory material. The molds rest on a car at the bottom of a long pit, which is deep enough to allow the top of the mold to reach to about the floor level. The molten steel is then poured from ladles like those in Fig. 6, which run on tracks on each side of the pit, and are thus carried directly over the molds.

After pouring, the mold containing the molten metal is moved by hydraulic pressure under the press shown in Fig. 3, which is the central and important feature of this department; not only as regards proportions, but in respect to its influence upon the product. The fluid steel is here subjected to a gradually increasing pressure during the cooling, causing the impurities and gases to segregate toward the center of the ingot. The outcome is an ingot of close and uniform texture that is solid throughout with the exception of the center, which is afterwards removed by boring. It takes eight or ten hours for an ingot to cool sufficiently to be removed, and during that time it is compressed about 10 per cent. in length. Ingots of this description have been cast 54 inches in diameter and about 16 feet long.

### Forging Department.

Now we come to the forging plant. Most of our readers know that there is here located the 125-ton hammer, the largest in the world, a model of which was exhibited at the Columbian Exhibition at Chicago, but it will probably be a surprise to many to learn that this hammer stands idle, although ready for use if required. All forging, except on small pieces, is done by hydraulic presses. The largest steam hammer in actual use is a six-ton hammer in the blacksmith shop.

The object of forging by hydraulic pressure instead of by the impact of the hammer blow is to allow the metal time to flow while being operated upon. The action of a hammer, especially when too light for the work, is to pene the outside of the piece, leaving the inside practically as it was originally. This is seen in the appearance of the ends of heavy forgings, which have a concave appearance when forged under the hammer, showing that the outer metal has been worked the most, while a similar piece forged under pressure will actually appear convex at the ends.

The main outfit of the forging plant consists of the 14,000-ton press shown in Fig. 2, operated by the 15,000 horse-power engine shown in Fig. 1; two similar but smaller presses of 5,000 and 2,000 tons respectively, operated by engines of 3,500 horse-power, and a bending press having two 36-inch plungers and 4 feet 8 inches stroke. This latter press is served by two cranes of 65-tons capacity, will take work 8 by 12 feet, and operates under a pressure of 7,000 pounds per square inch. This department is also equipped with heating furnaces, which heat the ingots, preparatory to forging, to the mild temperature of 1,200 or 1,500 degrees. That this is mild in comparison with the open-hearth furnaces is painfully evident to one who attempts to look into both of them, as did the writer.

The two smaller presses were obtained from the Whitworth works at about the same time that the compression plant was installed, and their satisfactory working led to the construction of the 14,000-ton press at the Bethlehem works. The fact that the company should construct so massive and expensive a group of machinery as this press with its crane, hydraulic apparatus and engines, shortly after building the giant 125-ton hammer, simply because it would do the work better than the hammer could do it, speaks volumes for the enterprise of the Bethlehem Steel Company and their determination to produce only the best products that can be made.

To the uninitiated it seems incredible that the full power of a 15,000 horse-power engine should be required to operate this one press, as stated under Fig. 2, but the writer was assured that such was the case, and a few figures show that it is not at all improbable. The hydraulic pressure at the pumps is 7,000 pounds per square inch, and the combined area of the two 50½-inch plungers of the press is 4,000 square inches. This times 7,000 pounds gives 28,000,000 pounds, or 14,000 tons, which is the rated capacity of the press. Fifteen thousand horse-power is equivalent to 45,000,000 foot-pounds per minute, and this quantity divided by 28,000,000, the pressure exerted, gives 17.6 as the number of feet per minute that must be traveled by the head to utilize 15,000 horse-power, supposing there to be no loss and that no power is required to raise the head after each stroke. Probably these two items would take at least one-third of this power, making the actual number of working feet required about 10 or 12, which is quite reasonable. The engine itself is a handsome machine designed by E. D. Leavitt. The pumps are ranged horizontally at the back of the engine and receive their motion from the steam cylinders through bell cranks, no power being transmitted through the shaft except to and from the fly-wheels.

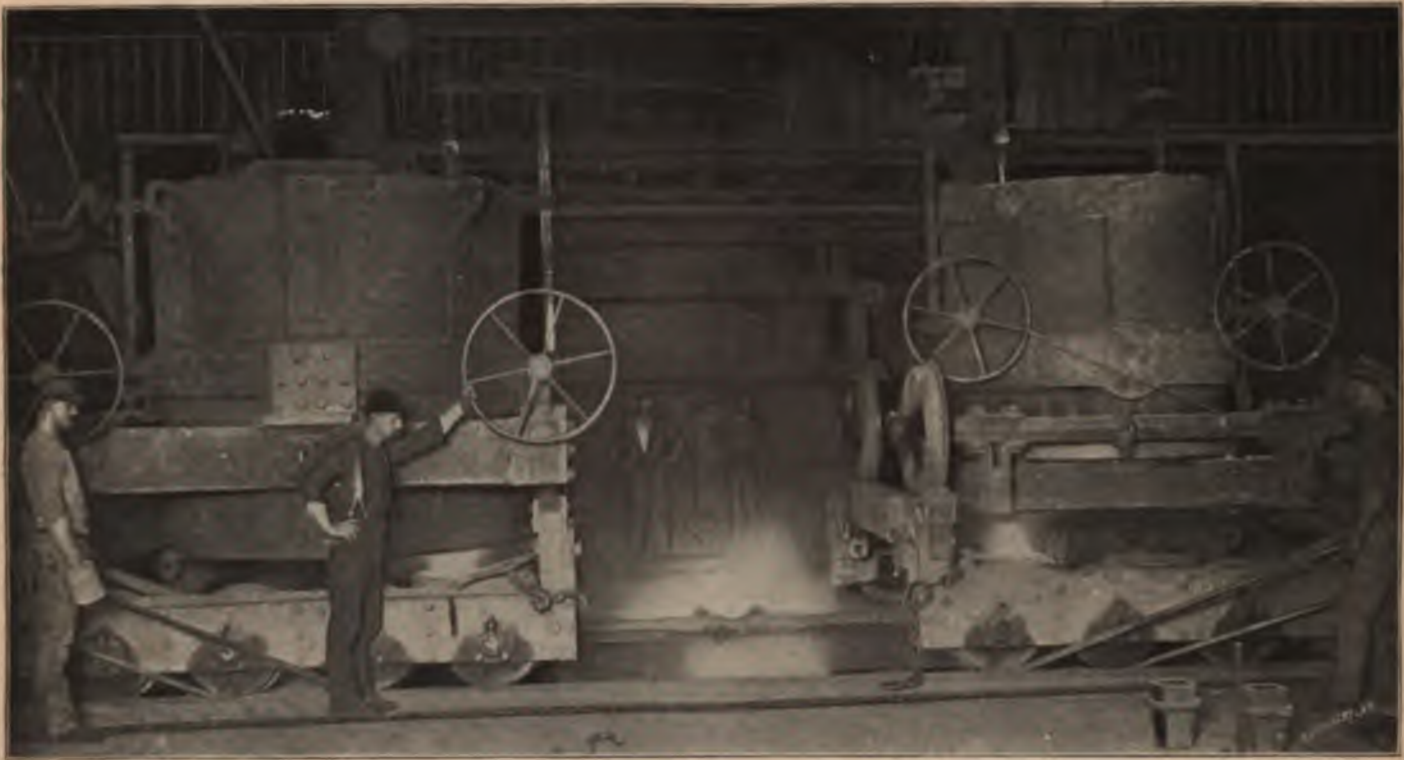


Fig. 6. Pouring an armor-plate ingot. Open-hearth furnaces on the platform at the rear.

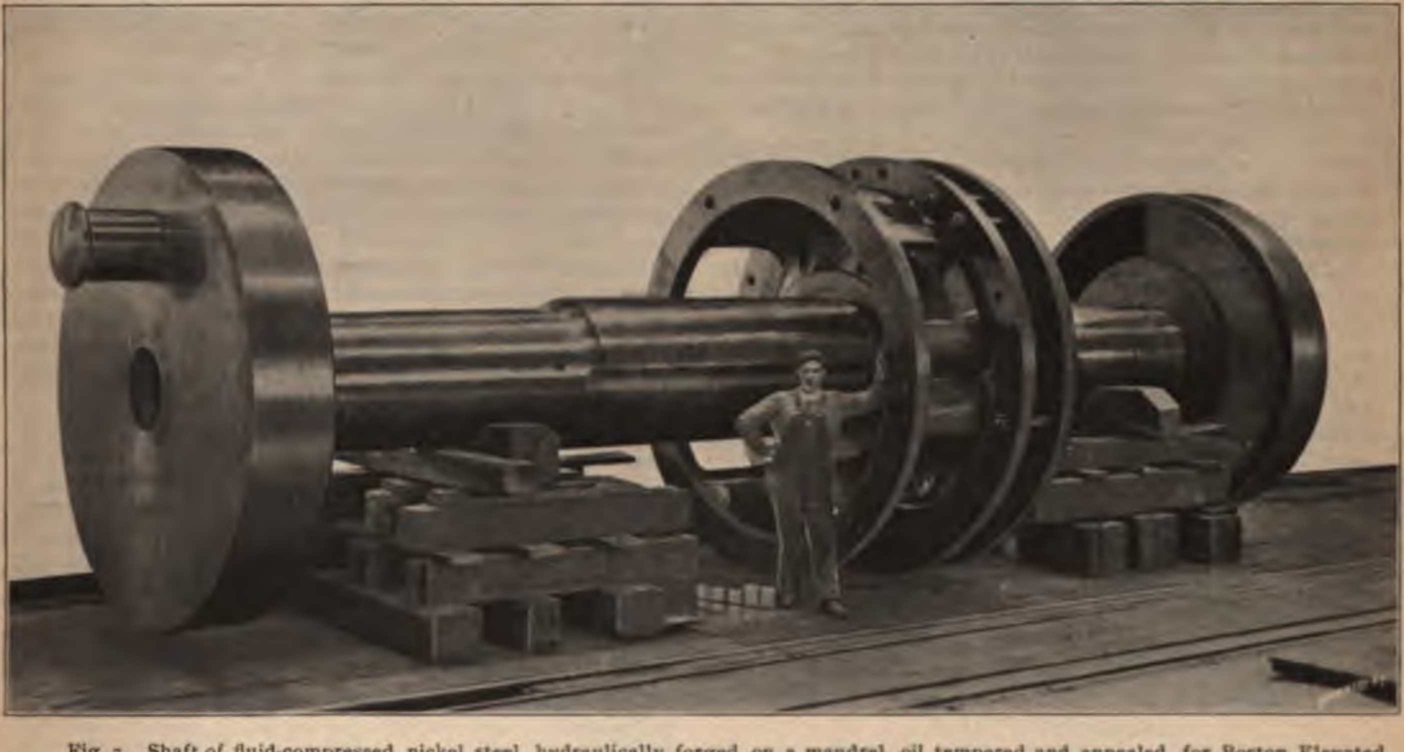


Fig. 7. Shaft of fluid-compressed, nickel steel, hydraulically forged on a mandrel, oil tempered and annealed, for Boston Elevated Railroad engine. Diameter in center, 37 inches; diameter of journals, 34 inches; diameter of axial hole, 17 1-2 inches; weight of shaft, exclusive of crank disks and hub, 65,400 pounds. The properties of the steel of the shaft are, elastic limit, 50,000 pounds per square inch and elongation 18 per cent. in test pieces 1 inch in diameter and 10 inches long.

### Hollow Shafts.

As intimated at the beginning of these notes, while the equipment of the Bethlehem Steel Company was designed primarily for producing armor plate, gun forgings and other government work, engineers engaged in lines of industrial work are taking advantage of its facilities and a large number of the forgings turned out are to supply this demand. Quite as important and as typical work as any is the making of large hollow shafts for steam engines, and a brief explanation of why these shafts are made hollow and of what results are obtained with them will probably be more instructive to the average reader than more detailed descriptions of other parts of the work and equipment.

It has already been stated that by the fluid compression process ingots are produced that are practically free from the defects of piping, blow holes and segregation; and that if there are any impurities they will occur at the center, which is bored out, leaving a perfectly sound cylindrical ring.

It might be supposed that the best way to make a hollow ingot would be to cast it hollow; but if this were done there would be two cooling surfaces while the ingot was solidifying, the interior and the exterior, and the metal half way between these, or at the central portion of the metallic ring, would be the last to cool and would contain the defects, which could not be eradicated. The casting would thus be far inferior to a solid casting bored out after cooling.

Another advantage of the hollow ingot over the solid one is that there is less danger in heating it to the temperature required for forging. The unequal strains incident to heating a large body of metal are likely to start a fracture which cannot be remedied in the forging. When a solid piece is treated the outside expands and tends to pull away from the interior. With the hollow ingot the heating takes place from both the interior and exterior sections and is more uniform.

When it comes to the forging, a steel mandrel of the size of the core that was bored out is inserted in the center, which amounts practically to reducing the thickness of the metal to be operated upon to less than one-half of what it would be if the ingot were solid. The mandrel acts virtually like an anvil at the center of the ingot and the annular ring of metal can be worked thoroughly, through and through, by the forging press, making it of superior texture. The importance of such working is shown by tests upon the first shaft of the U. S. dispatch boat Dolphin, which broke after a short service. The shaft was solid, 16 inches in diameter, and was forged from a large steel ingot under a 10-ton hammer. A test-piece from the outside, which had been worked, elongated 21 per cent. before breaking, while one from near the center, which had been scarcely affected by the hammer, elongated only 2 per cent., or practically was not ductile at all.

After a forging is completed, up to this point, it is then annealed to relieve the unequal strains that have been set up by the heating and forging. To use technical language, the shaft is heated to above the recalescent temperature and then allowed to cool slowly. This temperature lies between 1,200 to 1,300 degrees, Fahr., and is the point at which, if a piece of red-hot steel be allowed to cool, its temperature will cease to fall for a short time, or even may rise again, and then the same rate of cooling will continue as before this point was reached.

At the recalescent point the structure of steel seems to change; the old crystals rearrange themselves into new forms and internal strains are relieved.

The highest grades of shafting are oil-tempered by cooling in oil after they have been heated for annealing. The process of annealing reduces the elastic limit to below half the tensile strength, and oil tempering restores this property of the metal.

In Fig. 7 is an excellent illustration of the work done in the line of hollow shafts. Complete data are given under the illustration and it is only necessary to refer to these to convince one of the superior quality of the product. The fact that mild steel, which was formerly used when steel forgings began to be introduced, had an elastic limit of only 30,000 pounds, and that wrought-iron has but two-thirds of this, shows what can be gained in lightness and strength with the perfected material. Nickel steel may be stated roughly to contain 3¼ per cent. of nickel and from .30 to .40 per cent. carbon, the effect of the nickel being to raise the elastic limit without destroying the ductility. The high elastic limit of this steel combined with its ductility, makes it well adapted to withstand the alternating stresses that are imposed upon it. For as long as these stresses do not exceed the elastic limit and the shaft is a perfect forging, as a hollow shaft made by this method is quite sure to be, it should be absolutely safe.

* * *

As a preparation for his future work a young engineer cannot do better than to become a close reader of the current periodicals which have for their field his chosen profession. Let him follow the discussions and if possible take part in them; in order to do this with credit to himself, he must become familiar with the subject, and having once mastered it will easily recognize it when after a period of eight or ten years that same subject appears again thinly disguised and heralded as something that is really new. Many questions have a way of reappearing at more or less regular intervals, so that the elders of the profession have met most of them more than once."—Daniel Royse, in "Purdue Exponent."

## THE OCEANIC

### FEATURES OF INTEREST ABOUT THE LARGEST AND NEWEST OCEAN LINER.

The new White Star liner, the Oceanic, made her first trip across the Atlantic and arrived at New York harbor September 13th, after an uneventful voyage requiring a few hours over six days.

This huge vessel, the largest ever constructed, has occasioned considerable interest not only on account of her mammoth proportions, but because her building marks the great advance that has been made in maritime engineering since the days of that monumental failure, the Great Eastern. The dismal failure of this vessel had apparently set a limit to which no vessel could approach with any assurance of success, but the Oceanic exceeds the former vessel in dimensions, tonnage and power, although her engines consume only a fraction of the vast quantity of coal necessary for the propulsion of the great side-wheeler. The fuel consumption is an important factor in the status of an ocean vessel as a paying investment, and was one which caused the Great Eastern to prove a non-paying investment, as she required 12,000 tons for a round trip to the Orient, while the Oceanic, thanks to the greater efficiency of modern engines and boilers, has a steaming radius of nearly the same distance, or 24,000 miles, with a consumption of less than 4,000 tons.

The new steamer is 704 feet long, 68 feet wide, has a molded depth of 49½ feet, and total depth of 68 feet. Her draught when fully laden is 35 feet, but as the depth of the Sandy Hook channel is only 30 feet at high tide, it is evident that she cannot enter New York Harbor with a maximum lading until a deeper channel is provided. Her displacement is given as 28,000 tons, which, however, is increased to over 30,000 with the maximum draught. The engine power is rated at 28,000 H.P. with a steam pressure of 190 pounds per square inch, which is a striking contrast to that carried by the Great Eastern's boilers. The latter were intended for a pressure of only 20 pounds per square inch, and with the enormous consumption of coal were enabled to develop at the best, only about 8,000 H.P., which was divided between the side wheel and a supplementary screw. The latter's engines being of 4,500 H.P. and those for the side-wheels being 3,500 H.P.

The Oceanic, being a twin-screw ship, has two independent engines which are of the triple expansion four-crank type, the cranks being set so that practically equal turning moment is obtained at all points of rotation. The diameters of the steam cylinders are 47½ inches for the high-pressure, 79 inches for the intermediate, and 93 inches for the two low-pressure cylinders. The screws are so very close together as to necessitate an opening through the stern between them. The rudder is of extremely heavy construction and is of course provided with steam steering gear and also a hand gear to be used in an emergency. The steering gear is of very massive build and is provided with independent engines, so that in case one is disabled the other engine can be quickly brought into gear.

SOME OF THE DIMENSIONS OF THE LARGEST OCEAN VESSELS.

| NAME. | Length, feet, | Beam, feet | Depth, feet. | Draught feet. | Displacement, tons. | I. H. P. | Speed, knots. |
|---|---|---|---|---|---|---|---|
| Oceanic.......... | 704 | 68 | 40½ | 32½ | 28,000 | 28,000 | 21 |
| Great Eastern .. | 692 | 83 | 57½ | 25½ | 27,000 | 8,000 | 14½ |
| Deutschland..... | 662 | 67½ | 44 | .. | 23,000 | 35,000 | 23 |
| Kaiser Wilhelm Der Grosse.... | 649 | 66 | 43 | 29 | 20,000 | 27,000 | 22½ |
| Campania........ | 625 | 65 | 41½ | 28 | 19,000 | ..... | 22 |
| Lucania......... | 600 | 65 | 41½ | .. | 19,000 | 30,000 | 22 |
| Teutonic........ | 585 | 57½ | 42 | 27 | 15,000 | ..... | 20 |
| Paris............ | 560 | 63 | 42 | 26½ | 13,800 | ..... | 20 |
| City of Rome.... | 560 | 52 | 34½ | .. | 12,000 | 11,000 | 17 |
| St Paul ........ | 554 | 63 | 42 | 27 | 16,000 | ..... | 21 |
| La Touraine..... | 520 | 56 | 34½ | .. | 12,000 | 12,000 | 19 |
| Statendam....... | 525 | 60 | 41½ | .. | 17,000 | 6,200 | 15 |

There are fifteen boilers, twelve of which are double-ended and the other three single-ended. It is said that the weight of the entire battery is nearly 1,100 tons. It by no means follows, however, that all these boilers are required for the main engines, as there are between seventy and eighty auxillary engines for operating the hoists, electric lighting apparatus, pumps, fans, etc. As these engines are distributed throughout the ship wherever needed, and as they require steam pipes from the boilers and exhaust pipes to the condensers, it follows that there is a very complicated mass of piping required in the aggregate. Twenty engineers are required to look after the various units throughout the vessel, including the electrical and refrigerating engineers with their assistants. One of the impressive features of the Oceanic are the two towering funnels which reach 140 feet above the keel. Their shape is elliptical in sections, the two diameters being 15 and 19 feet, which, however, is less than the diameters of the stacks for some of the Cunard ships.

While the dimensions of the Oceanic are enormous, her lines are so trim and well proportioned that the impression of size is not realized until she is compared with the pier shed or to one of the saucy little tugs that bustle so busily about New York Bay and the Hudson River. An interesting sight is that presented when such a vessel as the one under consideration is being docked and seven or eight tugs are all working with their noses against the side of the vessel to counteract the effect of the tide so that no damage shall be done to the piers while the ship slowly moves up to her position.

A peculiar feature of the construction is the use of huge round head rivets in the upper rows of plates, while those below are of course countersunk so that a smooth surface is obtained. The plates are of extraordinary thickness, and it is said that the rivets used are of a larger diameter than have ever been used throughout the construction of a similar vessel. The use of such large rivets was possible by the use of huge hydraulic riveting machines on all parts of the ship, practically no hand riveting being done on her plates or frame work.

The vessel has seven decks exclusive of that on which the officers' quarters are placed, and which is also used for the storage of the life boats. The accommodations for the passengers are very complete, especially those for the first and second cabins, and even the steerage is said to be superior in the general conveniences and comfort to the second cabin arrangements of only a few years ago. All details are carried out with extreme nicety, and the finish of all the parts of this immense structure is one of the things that most impress a person who understands the vast amount of labor required to secure such results. The total cost of the Oceanic, which was built at Belfast, Ireland, by Harland & Wolff, is said to be nearly $5,000,000.

* * *

## STANDARD KEYS.

### PROPORTIONS FOR STRAIGHT AND TAPER KEYS, WITH DERIVATION OF THE FORMULAS.

Henry Hess.

In determining a standard it is proper to consider just what offices the thing to be standardized is to perform, and the conditions of its use.

All keys to be discussed are intended to transmit motion from a shaft to a surrounding hub, or vice versa, in doing which the force acting on the key tends to produce, first, tilting of the key in its seat, and, second, a shearing of the key along the joint of hub and shaft. The first of these tendencies is restrained by the depth of the key; the greater this is the less tendency to rock; but letting the key in deeply tends to weaken both hub and shaft, and it therefore becomes necessary to compromise. A very good proportion for depth and one already largely adopted is to make

$K = \frac{3}{16} d + \frac{1}{16}$, where K is key depth and d is shaft diameter. For most cases a key of square cross section is preferable, so that $w = K = \frac{3}{16} + \frac{1}{16}$, where w is key width.

Such a width and depth will weaken a shaft against tension by only about 7 per cent., one half of the key being let into the shaft.

The second of the destroying tendencies, the shearing of the key, is resisted by giving the key a proper area of shearing section; this area $= l\ w$, where l is length of key and w is width of key as before.

As w is already empirically determined, only l remains to be found. If the shearing area is made such as to have a resistance to shear equal to that of the shaft against tension it will be ample. Such area will be secured if $l = 1.65d - 0.35$, or for diameters up to 6 inches a simple formula, giving somewhat greater strength, is $l = 1.6d$.

This, of course, means not that l must always be made to conform to the value given by the formula, but that it should never be less.

**Proofs of these Formulas.**

For those interested, the proofs are as follows:

KEY LENGTH.

$L = l\ w\ f$ ........................................ I.

Where L is load acting at shaft radius,
w is width of key,
f is shearing stress,
l is length of key.

The formula for shaft under torsion is

$L = \frac{\pi}{16} f_1 \frac{d^3}{r}$ where ........................................ II.

v is shaft radius,
d is shaft diameter,
$f_1$ is torsional stress,

but as resistance to torsion of any given material is 4-5 of that to shear, $f_1$ of equation II equals 4-5 f, and as $r = \frac{d}{2}$ equation II may be written.

$L = \frac{\pi}{16}\frac{4}{5} f \frac{d^3}{\frac{d}{2}} = \frac{\pi}{16}\frac{8}{5} f\ d^2$ ........................................ III.

From I. and III. it follows that

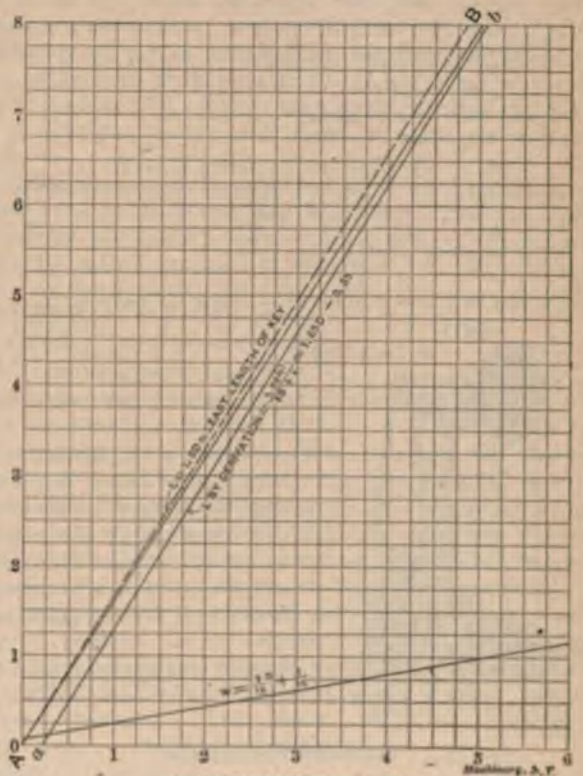
$l\ w\ f = \frac{\pi}{16}\frac{8}{5} f\ d^2$, and cancelling f gives

$l\ w = \frac{8}{16}\frac{\pi}{5} d^2$; but as $w = \frac{3}{16} d + \frac{1}{16}$

$l \left(\frac{3}{16} d + \frac{1}{16}\right) = \frac{\pi}{16}\frac{8}{5} d^2$, which transposed and reduced gives

$l = \frac{\pi}{16}\frac{8}{5}\frac{d^2}{\frac{3}{16}d + \frac{1}{16}} = \frac{\pi}{16}\frac{8}{5}\frac{d^2}{\frac{1}{16}(3d + 1)} = \frac{5.03\ d^2}{3d + 1}$

DIMENSION CHART.



This formula may be simplified by graphic method, as follows: First calculating a number of values of l gives

| l | d |
|---|---|
| 1 | 1.26 |
| 3 | 4.53 |
| 4.5 | 7.44 |

Plotting these values of l as ordinates to the values of d as abcissae on a piece of cross section paper gives a line a b that intersects the base between o and 1. Draw a line A B from o parallel to a b; at any value of d measure the ordinate to A B and divide the value thus found by d. At d = 4.5 the ordinate measures 7.44 and $\frac{7.44}{4.5} = 1.65$. Next measure vertically from a to B, which is found to equal 0.35. Therefore

$l = 1.65\ d - 0.35$.

Drawing a line from o to point d = 5 on line 8 of the diagram gives a formula for l having only a constant multiplier and dropping the second term, or $l = \frac{8}{5} = 1.6\ d$.

It will be noticed that this formula gives values slightly large for all values of d below 6".

This graphic method for simplifying formulae may very often be put to good use, whenever the line representing the plotted values is a straight one.

### Weakening Due to Keyway.

The statement made in the beginning that a width $w = \frac{3}{16}d + \frac{1}{16}$ and depth $\frac{w}{2}$ of the keyway weakens the shaft by only 7 per cent. is proven as follows:

The polar moment of J of a shaft of circular crosssection is

$$J = \frac{\pi}{32} d^4.$$

The polar moment $J_1$ of a shaft having a keyway cut out is J minus the polar moment of the section cut out referred to the shaft center; this latter moment is the sum of two equatorial moments around axes at right angles to one another and passing through the shaft center: these equatorial moments are:

$J_2$ around a a, and $J_3$ around b b. See diagram.

$$J_2 = \frac{w}{2}\,\frac{w^3}{12} = \frac{w^4}{24}$$

$$J_3 = \frac{w}{12}\left(\frac{w}{2}\right)^2 + A^2\left(w\frac{w}{2}\right) = \frac{w^3}{48} + \frac{(A\ w)^2}{2}$$

$$J_1 = J - (J_2 + J_3)$$

Let d = 1, then

$$w = \frac{3}{16} d + \frac{1}{16} = .25$$

$$A = \frac{d}{2} - \frac{w}{4} = \frac{1}{2} - \frac{.25}{4} = .4375$$

$$J_2 = \frac{w^4}{24} = \frac{.25^4}{24} = .00016$$

$$J_3 = \frac{w^3}{48} + \frac{(A\ w)^2}{2} = \frac{.25^3}{48} + \frac{(.4375 \times .25)^2}{2} = .00631$$

$$J = \frac{\pi}{32} d^4 = \frac{\pi}{32} 1^4 = .09817$$

$$J_1 = J - (J_2 - J_3)\ .09817 - .00016 + .00631 = .0917$$

$$\frac{J}{J_1} = \frac{.09817}{.0917} = 1.07, \text{ that is}$$

the shaft without keyway is 1.07 times or 7 per cent. stronger than with keyway.

Strictly this analysis is not quite correct. If a shaft be conceived as being pierced with a very narrow sawslit in the direction of its length, so narrow that the amount of material removed is practically nil, it is very clear that it will not be as strong to resist tension as it was before cutting. This is, however, an extreme case, and though the amount of weakening as above is understated it is for the depth of keyway given not seriously so.

The table gives the dimensions of straight and taper keys, and may prove a useful addition to other data published by MACHINERY.

### Standard Taper Keys.

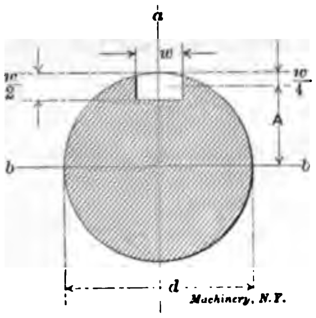
Taper keys are called on theoretically to act only by frictionally binding together shaft and hub, all driving to be due to this frictional hold only. As a matter of fact, taper keys are more or less liable to be jarred loose, and can therefore not be relied on to secure a driving by friction only, so that, as in the case of ordinary keys, their area of cross-section at the junction of hub and shaft should be relied on to be on the safe side, thus narrowing the junction of the taper down to a more or less efficient means of keeping the key in place. General practice seems to argue that a taper of one in sixty-four is a fair value and gives dimensions that work in well with the usual subdivisions of the inch. In Europe a taper of one per hundred is generally employed, agreeing better with the decimal system in use there.

As the key has finally to act in a manner similar to the ordinary flat key, its dimensions will be governed by similar considerations, so that the width and average depth are as before

w $\frac{3}{16}$ d + $\frac{1}{16}$

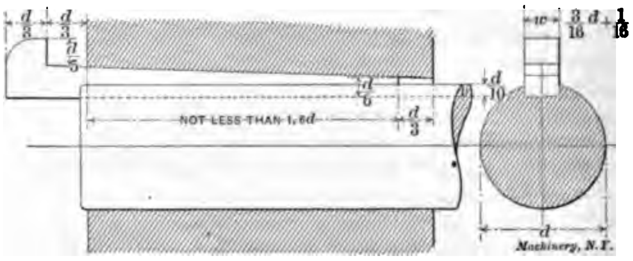
Keys proportioned as that shown will be found to give a fair shoulder both at the head and point to drive against in backing out, with sufficient clearance for occasional tightening, and a symmetrical head. All proportions are based as simply as possible on the diameter. For very long keys of 5 dias or more a taper of one in sixty-four gives rather too great a depth under the head, and it is advisable to reduce this to one in a hundred; there is, however, very rarely any need of such keys, as a length of 1.6 dias is all that is required to secure strength fully equal to that of the draft.

### KEY DIMENSIONS.



**In the taper key the least length l is that at which the key in shear and the shaft in torsion have equal strength for the same material.**

STRAIGHT KEY.



TAPER KEY.

TABLE.

| | Straight and Taper Keys. | | | Taper Keys Only. | | |
|---|---|---|---|---|---|---|
| d | w | $\frac{w}{2}$ | l | $\frac{d}{3}$ | $\frac{d}{5}$ | $\frac{d}{6}$ |
| 1/2 | 5/32 | 5/64 | 3/4 | 5/32 | 3/32 | 3/32 |
| 5/8 | 3/16 | 3/32 | 1 | 7/32 | 1/8 | 3/32 |
| 3/4 | 3/16 | 3/32 | 1 1/4 | 1/4 | 5/32 | 1/8 |
| 7/8 | 1/4 | 1/8 | 1 3/8 | 9/32 | 5/32 | 1/8 |
| 1 | 1/4 | 1/8 | 1 5/8 | 11/32 | 3/16 | 5/32 |
| 1 1/4 | 5/16 | 5/32 | 2 | 13/32 | 1/4 | 3/16 |
| 1 1/2 | 5/16 | 5/32 | 2 3/8 | 1/2 | 9/32 | 1/4 |
| 1 3/4 | 3/8 | 3/16 | 2 3/4 | 9/16 | 11/32 | 5/16 |
| 2 | 7/16 | 7/32 | 3 1/8 | 11/16 | 3/8 | 11/32 |
| 2 1/4 | 1/2 | 1/4 | 3 1/2 | 3/4 | 7/16 | 3/8 |
| 2 1/2 | 1/2 | 1/4 | 4 | 13/16 | 1/2 | 13/32 |
| 2 3/4 | 9/16 | 9/32 | 4 3/8 | 15/16 | 17/32 | 7/16 |
| 3 | 5/8 | 5/16 | 4 3/4 | 1 | 19/32 | 1/2 |
| 3 1/4 | 5/8 | 5/16 | 5 1/8 | 1 1/8 | 5/8 | 17/32 |
| 3 1/2 | 11/16 | 11/32 | 5 1/2 | 1 3/16 | 11/16 | 9/16 |
| 3 3/4 | 3/4 | 3/8 | 6 | 1 1/4 | 3/4 | 19/32 |
| 4 | 13/16 | 13/32 | 6 3/8 | 1 5/16 | 13/16 | 5/8 |
| 4 1/4 | 7/8 | 7/16 | 6 3/4 | 1 3/8 | 7/8 | 11/16 |
| 4 1/2 | 7/8 | 7/16 | 7 1/8 | 1 1/2 | 7/8 | 3/4 |
| 4 3/4 | 15/16 | 15/32 | 7 1/2 | 1 5/8 | 15/16 | 25/32 |
| 5 | 1 | 1/2 | 8 | 1 11/16 | 1 | 13/16 |
| 5 1/4 | 1 | 1/2 | 8 3/8 | 1 3/4 | 1 | 7/8 |
| 5 1/2 | 1 1/8 | 9/16 | 8 3/4 | 1 7/8 | 1 1/8 | 15/16 |
| 5 3/4 | 1 1/8 | 9/16 | 9 1/8 | 1 15/16 | 1 1/8 | 31/32 |
| 6 | 1 1/4 | 5/8 | 9 1/2 | 2 | 1 1/4 | 1 |

The dotted lines of the dimension chart give the actual dimensions called for by the proportions given at the key, while the full lines give the absolute dimensions to be used.

* * *

To one with aesthetic tastes in machine design the English locomotive easily ranks ahead of the American. Its graceful and smooth contour is not marred by the numerous projections and irregularities found on our machines. But when it comes to repairs and the care of the machine—that is another thing.

# MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—3.

## TESTING AND ADJUSTING ENGINE LATHES.

W. H. VAN DERVOORT.

The size of a lathe is commonly determined by its swing and the length of the bed, the swing referring to the greatest diameter of work, when held on the face plate or in a chuck, that the lathe will turn over the shears. Thus, an 18-inch by 10 foot lathe means one that has a bed 10 feet long and will swing work 18" in diameter. The builder usually allows from ⅛ to ½ inch over the rated swing, thus making it possible to actually finish a piece of work of the same diameter as the normal swing of the lathe. The swing over the carriage and greatest distance between centres are also important dimensions. The former is usually from one-half to two-thirds the normal swing of the lathe.

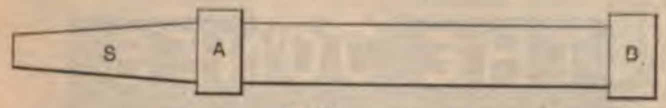


Fig. 19

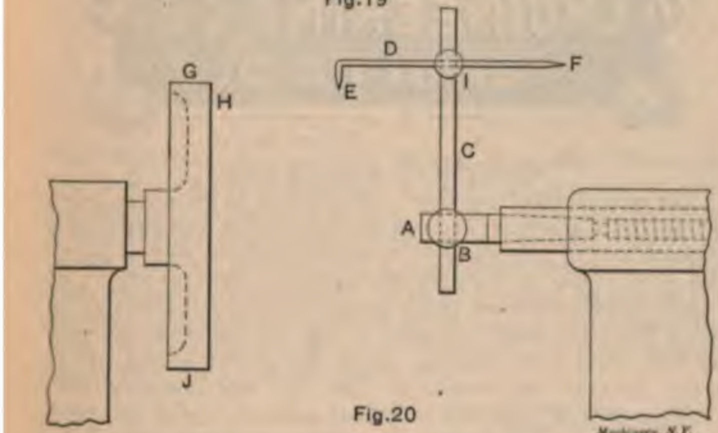


Fig. 20

Machinery, N.Y.

The lathe should be well and accurately built, of ample weight, with operating parts conveniently arranged. Weight is desirable and usually indicates a first-class tool. This is not necessarily true, however, as frequently a badly designed machine will have certain parts excessively heavy with other parts correspondingly light, the whole often making an unusually heavy machine,—not so good as the lighter machine in which good judgment on the part of the designer has led to proper proportions for all the parts.

Lathe builders carefully test the accuracy of their lathes before sending them out. As it is frequently desirable for the mechanic to test his lathe as to accuracy of alignment, or in making repairs on lathes that have become inaccurate through wear, the following methods, commonly employed for this purpose, may be of value.

To determine if the centre bearing in the live spindle is axially true with its spindle: Turn up, on accurately ground centres, the test bar shown in Fig. 19. The shank S should fit the centre bearing nicely and the collars A and B should be exactly of the same diameter. Place the test bar in the live centre bearing, leaving it unsupported at the outer end, and cause the spindle to rotate. If the outer end of the bar runs perfectly true, then the bearing must be concentric with the spindle.

To test the parallelism of the live spindle and the shears: If the centre bearing has been found exactly concentric, place the test bar in the bearing as before. Put a fine pointed tool or scriber in the tool post and so adjust that it will just touch the top of the collar A. Now move the carriage until the pointer is over the collar B. If it touches it with the same degree of contact as on A, the spindle must be horizontally parallel with the shears and line of motion of the carriage. In like manner test the front side of the collars A and B with the scriber, and if as before the degree of contact is the same on both, the spindle must be vertically parallel with the shears.

To test the carriage cross shears at right-angles to the spindle: Take a very light cut over the large face plate and test with a standard straight edge. If perfectly plane, the alignment is correct. If the face plate is perfectly true and it is not desirable to take a cut over it, a smooth ended tool held in the tool post can be brought up to the face of the plate, near the centre, just close enough to pinch a piece of paper lightly. Now move the rest out to the outer edge of the plate without allowing the tool or carriage to shift along the bed, and if the paper is still pinched to the same degree the alignment must be correct.

Assuming the face plate as true both on its face and circumference, to test the alignment of the tail spindle: Make a stub A to fit the tail spindle bearing as shown in Fig. 20. Bring the spindle back until the tail screw starts to expel the stub centre A, and so adjust the screw that when A bears against its point a smooth turning fit between A and the spindle bearing results. C is an arm passing through A and secured by the thumb screw B. D is a pointer which passes through the arm C and is held by the thumb screw I. Adjust the point E so it touches the upper surface of the circumference of the face plate at G. Next swing the arm around until point E comes on the bottom of the plate at J. If E touches at J with same degree of pressure as at G, then the tail spindle must be at the same height as the live spindle, and in like manner if it bears equally on the two sides of the plate the cross adjustment must be right.

In order to determine whether the centre line of the tail spindle is coincident with that of the live spindle we can reverse the point of D and bring F into contact with the face of the plate at H. If it maintains uniform pressure of contact while the arm C is revolved entirely around, then the dead spindle is central and parallel with the live spindle.

If the tail spindle has been set over for turning taper and it is desired to bring it back central, first set it as near to the correct position shown by the lines as possible, then place a long bar between centres, similar to the one shown in Fig. 19, and take a very light cut over the collars A and B without changing the transverse position of the tool. Caliper the diameters of A and B accurately. If they are not alike, make another set-over adjustment of the tail stock and repeat, continuing to do so until they caliper exactly alike. Two trials will usually be found sufficient.

To test the truth of the live centre, place a bar between centres and turn a small pointer up as close to the live spindle as the dog or driver will permit; then reverse ends with the bar and test the turned spot for truth of rotation. If perfectly true the live centre is running true. The centres in the test bars should always be carefully reamed and lapped or worn down to true surfaces.

It is difficult to keep the lathe centres in good condition and accurate work demands that they be so kept. The dead centre must be true and hard in order to wear well. The live centre need not be so hard, inasmuch as there is no wear between it and the bearing in the work. The live centre should be ground in position by means of a center grinder, such a device being shown in Fig. 21. After being ground the live center should be removed from its bearings in the spindle only when absolutely necessary, as it is practically impossible to put it back and have it perfectly true. A small prick punch mark on the nose of the spindle and a corresponding one on the center will enable the operator to put the center back as nearly as possible in its correct position. It is advisable, where nice work is to be done, to always grind the live center after it has been removed. The center should always be ground to an angle of exactly 60 degrees.

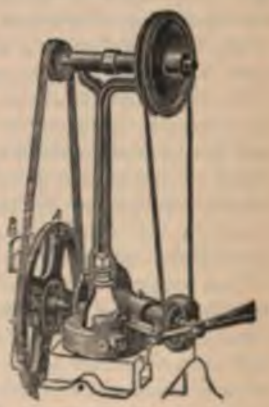


FIG. 21.

One of the first and simplest jobs the beginner does in the lathe is to turn a plain spindle. He can begin, even on this job, to exercise his judgment. For example, he is given a bar of round steel 2" in diameter and is to make a plain, straight and true spindle 1⅞" diameter by 2 feet long. In cutting this bar he must make the necessary allowance for squaring up the ends. If cut in a cut-off machine, 1-32" will do; if in the power hack saw 1-16" should answer if the saw is running reasonably true, while ⅛" or even ¼" would usually be required if haggled off in the blacksmith shop. Having cut the bar and made the required allowances in length, he next centres it with punch and hammer. As a beginner he must use the caliper dividers or "bell centre" punch for finding these centres; but as he becomes more experienced he finds for work of small diameter, at least, that his eye is quite as good as either of these tools. If he is in an up-to-date shop he centre drills the ends with a combination drill and centre reamer, which makes them look about as shown in A in Fig. 22. He now squares off the ends with a side cutting tool, and how easily he gets them square to the very centre by slacking back slightly on the tail spindle and allowing the tool to cut into the centre. He must be particular about getting the bar to exact length in this operation, and when finally to length the ends must look as shown at B in Fig. 22. To leave an end as shown at C Fig 22 is unpardonable, even on the roughest kind of work. When left as shown at B a reliable centre can be had at any time should it ever become necessary to place the spindle between centres again.

He should next rough to within about 1-32" of the finished diameter for a length of from three to four inches from the tail centre. In doing this the centre bearing at that end becomes worn down to a nice, true bearing. The work is now changed end for end and the balance first roughed down and then finished. It should be here noted that no part of the work should receive its final finishing cut until it has all been roughed over. The reasons for this are, first, that the centres should be worn down to true bearings, and second, because of the springing due to removing the fibre strains in the metal. If a part be given the final finish before the balance is roughed down, that part will usually be found out of true after the last roughing. Not only is this the case with the rolled metals, but with the cast as well, where the removal of the skin or scale usually causes the work to change somewhat in form.

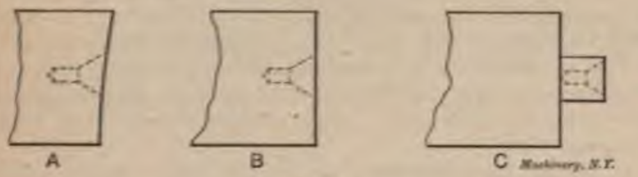


FIG. 22.

The required quality and truth of the finished surface must determine the number of cuts to take. For the roughest work a single cut will frequently do, and for general work two cuts, the first a roughing leaving only enough for a finishing cut. The latter cut should always be a light one. When a very nice, true surface is desired three cuts are advisable; a roughing, a sizing and a finishing cut.

In turning the above bar the young mechanic should learn a lesson in cutting speeds. Mild steel can be machined at from 20 to 30 feet cutting speed per minute, depending on its hardness. The beginner usually runs way below speed, and as he has no experience upon which to base his judgment in speeding the work, he should make a simple calculation in each case until his eyes tell him the proper speed without figuring it.

As the circumference of the work is approximately three times the diameter, he would in the present case have the work moving to the tool about six inches per revolution. At a cutting speed of say 25 feet per minute, the work should make about fifty revolutions per minute. Chalking a spot on the face plate and counting the revolutions will determine quickly whether or not the speed is correct.

This matter of speed is of very great importance, not only in its effects upon the output of the lathe, but upon the workman himself, as he quickly becomes tuned with his machine and loses that snap and vigor at his work which comes from seeing everything move along at a quick, business-like pace.

The young mechanic should familiarize himself at the beginning with all the details of construction and manipulation of the lathe itself. He will necessarily do work slowly at first, but he must learn accuracy from the beginning. The speed will come as he improves in skill and gains in confidence.

He must learn early the power of the machine, the strength and wearing qualities of the cutting tools and the strength of the materials upon which he operates. He will then not overtax the machine and break or injure the tools and work; neither will he take three cuts over a piece of work when two would have answered quite as well.

If the surface is to be a polished one, he must make some allowance for filing and finishing with emery. This is a matter of judgment, and the beginners judgment is usually poor, as he leaves altogether too much to remove with the file, which takes up time and injures the true of the work. It is very difficult to file much on rotating work and keep it cylindrically true. The finishing cut should therefore leave the surface smooth, true and within one to five thousandths of finished size, depending on the degree of accuracy required.

* * *

Machinery New York

### CHAPTER II.—A BLOW-OFF.

The next morning everybody was hustling at the works, when in walked a pompous looking gentleman, the proprietor of a woolen mill of considerable importance and the men at Jones' felt it their duty to maintain the dignity of their concern. The "cub" seized an oil can and began to oil up promiscuously; he oiled the loose pulley to make it slip and he oiled the belts to keep them from slipping, and as the grindstone was out of water he oiled the surface of that. He was "showing off." The blacksmith, "clad in a little brief authority," fired off orders to his striker loud enough to be heard out in the yard. He was "showing off." Young Jones "showed off" by running hither and thither with his hands full of tools and making a good deal of the fuss and splutter that insect authorities delight in. The "old man" fell to "showing off," delivering decisions and discharging directions at whoever came his way and above all the visitor beamed a majestic and condescending smile on the little shop and warmed himself in the glow of his own grandeur. He, too, was "showing off." "Mr. Jones," said he, "do you understand the mechanical construction of a safety-valve?" "Safety-valve, why sir, I was brought up on a safety-valve! I've made 'em for all sorts of purposes; made one for my wife to put into a pie to keep it from running out!"

Without noticing the flippant interruption the great man invited Jones over to his mill and on the way he explained that he was making some changes which necessitated running a steam-pipe right where the lever of his safety-valve came, yet for several reasons he did not wish to move the valve, and he wished for Jones' suggestions. After studying the situation, Jones delivered the following decision. "Now you see, sir, it's like this: them levers is governed by a principle and if ye understand that principle you can do pretty much anything with them. We calls it the principle of multiplication; it's kind of a doctrine of long arms and short arms. This lever you say is in your way. Now if we take the long arm of it and bend it right up into the air where there is more room it ought to multiply just the same, provided we don't change the length of the arm, d'ye see, sir? Well, then we can run a rod across the boilers and hitch to a bell-crank and use the same balance weight you've got a'ready, and I can hitch it into the right notch first time trying; if I don't, I'll eat it!" This argument seemed so plausible that the mill owner told him to go ahead, and before the next morning the rig was in place as shown in Fig. 5.

Jones went down early to visit "Mac," the Scotch engineer, and see how he liked the arrangement. "Mac," said he, "What was the safety-valve set to blow off at before we changed the lever?" "A hoondred poonds," Mac replied.

"Fire her up Mac and let's see her blow off. When I get a thing all figured out as well as that I like to see it work."

"Seventy poonds," called out the engineer as though he was a pilot taking soundings. "Smart trick that," Jones continued, "The old man was afraid we would have to move the valve, but I showed him a way worth two of that.". "Seventy-five," sung out the Scotchman, who was watching the gauge more intently than he was the story. "Oh, never mind the small change," Jones exclaimed, "run her up to par. I didn't spend half the night setting your old safety-valve at any fractional denomination. When she reaches a hundred, she'll blow off and not before." "Eighty pounds," the hand of the steam guage quivered, there came a pop and a swish and the valve was blowing off!

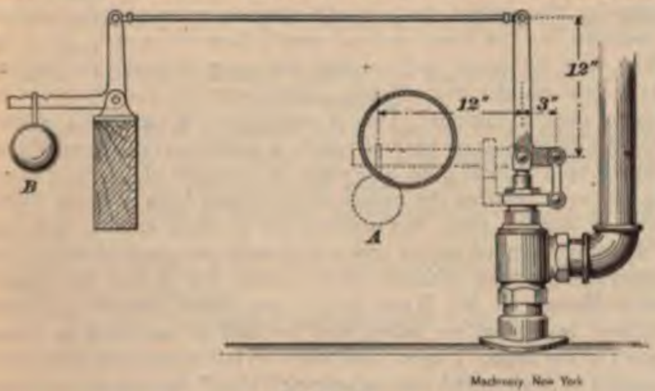


FIG. 5.

The expression on Jones' face changed from astonishment to incredulity, then to disgust and he started for home to try and figure out the mystery—why with the same valve and the same weight and the lever arms the same length as before the valve should blow off at 20 pounds less indicated pressure. As for Mac, he showed his contempt for all such trappy devices by remarking, "These domd Yankees think they are so smart that they can tak a paper o' pins and improve on the steam engine. Eh, mon, if Stevenson had only lived!"

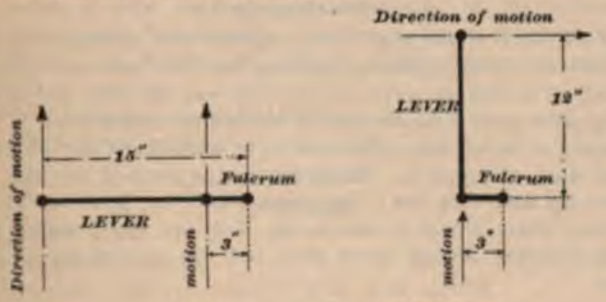


FIG. 6.

It will be seen by those who followed the articles on levers in MACHINERY a year ago that our friend the "old man" deceived himself when he bent the lever at right angles. While it was still subject to the same laws as before he failed to understand those laws. The length of the lever should be measured at right angles to the line of motion and the lever which multiplied five times when straight only gave a multiplication of four when bent.

W. H. S.

* * *

"If a young engineer is so situated that he can contribute to the technical press as a writer it will be of distinct advantage to him to do so. He acquires the ability to express himself well; he learns to think straight (or he is quickly found out); he will become known to his future clients. The discussion which may arise on the subject will be at comparatively short range because publication is not delayed for weeks or months; an inexperienced writer is given a better chance to consider any reply to questions and criticism than is offered in oral debate at a society meeting; moreover, the men who take part in such discussions do so because they are interested in the subject. Lastly, the pecuniary reward is not to be despised."—Daniel Royse in "Purdue Exponent."

* * *

A great forging press of 10,000 tons capacity has been built for the Dillingen Iron Works, Germany. While this is an immense machine, America still holds the lead, for the press at Bethlehem, Pa., is of 14,000 tons capacity.

## FAMILIAR SUBJECTS IN MECHANICS.—5.

### BELTING AND PULLEYS (Continued).

SAMUEL WEBBER.

I thought, when I began, that two letters would exhaust all I could find to say on the subject of pulleys and belting; but I find that I have as yet omitted to call attention to the especially important factor on which the transmission of power by such methods depends; that is, the "coefficient of friction." There appears to be some difference in opinion among various writers as to what this is, how great it is and how to ascertain it, and I will therefore explain my understanding of "what it is" in the first place. I consider it to be the amount of the power applied to a shaft by the friction of a belt on the surface of a pulley which that shaft will deliver at some other point, either to another belt, or to a train of gears, or in any other manner. That is, if 10 horse-power is applied to the surface of a pulley, and the shaft delivers 5 of it at some other point, the "coefficient of friction," or the proportion realized, is 50 per cent., or 0.500, as expressed in decimals. Morin gave it as his conclusion, from the result of his experiments, that 50 per cent. could be thus obtained, and the experiments of Messrs. Briggs and Towne, published many years since, gave it as 42 per cent. Now, while, as the experiments I have been recording show, I have obtained a coefficient of over 50 per cent. under favorable circumstances, I am inclined to fall back on the results of Messrs. Briggs and Towne, and adopt 42 per cent. as a safe and reliable factor.

To illustrate this point, I will refer to the tests of the flexible "Schutz" belt, on page 382 of MACHINERY for August, and first take up the test of this belt on iron pulleys with a brake load of 160 lbs.., a belt speed of 667 feet per minute, and a slip of 2 per cent. I allow this slight slip, because all other writers have done so to the best of my memory.

Now the initial strain on this belt was 83 1-3 lbs per inch, or 1,000 lbs on 12 inches. As the strain was equal on each side, the pulley received twice this, or 2,000 lbs., and this multiplied by 667 feet per minute, gives 1,334,000 lbs., one foot per minute, or 40.4 H.P. applied to the surface of the pulley. The brake power realized from the shaft was 16.69 H.P., and dividing this by 40.4, we get 0.413, as the "coefficient of friction," as stated in the tables. When applied to the wooden pulley, with a brake load of 180 lbs., and the same tension, we got, at 691 feet belt speed, 19.80 H.P. without any slip, and a coefficient of 47.1 per cent. With 3 per cent. slip we obtain 48.5 per cent., and finally, by increasing the load, attained 61.2 per cent., without apparent increase in slip, and a total power of 26.16 H.P., which practically exhausted the engine.

This, however, was an exceptionally soft and flexible belt, and as the new "Hoyt" belt, of regular manufacture only gave .420 when applied flesh side to the pulley, or exactly Messrs. Briggs and Townes figures (see p. 381). I feel disposed to recommend that as a standard.

Some writers on this subject have given much higher coefficients of friction, as the result of their experiments, even reaching over 100 per cent., but as that is a mechanical impossibility, like the old story of the man "who lifted himself over the fence by his bootstraps," such statements only vitiate all their conclusions and reported results.

One of the recent papers read before the American Society of Mechanical Engineers, recommended a speed of 12,000 to 14,000 feet per minute for the transmission of one horse-power by each inch in width of a double belt, but the experiments from which these figures were deduced were evidently made with narrow machine belts, probably laced, on heavy tools, and with the idea of making the belts last as long as possible and do not represent the real driving power of a belt. I see no reason to alter the figures I published many years since and gave Mr. J. H. Cooper for the first edition of his "Notes on Belting:" viz., that 600 feet per minute for a single belt, and 400 feet for a double one, was sufficient velocity to enable each inch of width to convey one horse-power.

These figures were based on the experiments of Morin, Briggs and Towne, Kirkaldy, and many others, on the strength of leather, and are applicable only to what may be called "permanent belts," *i.e.*, belts cemented at the joints, and running constantly in one position. The figures I have copied in these articles will prove the correctness of these estimates, and are fully corroborated by over half a century's experience among belts and pulleys.

It may be well to state, also, that I call the thickness of a single belt, from 1-6 or 3-18 of an inch, to 3-16 inch; of a light double belt, ¼ inch, and a heavy double belt ⅜ inch, and I may say, also, that I have known a heavy double belt transmitting over 600 H.P. for many years, at a speed of less than 300 feet per minute, for each inch horse-power."

When it comes to a question of narrow machine belts, I do not pretend to be governed by these rules, as the strength is then only that at the lace holes. In such cases I add 50 per cent. to the necessary velocity, and when stopping and starting up again are frequent, or the belt is often "shifted" from fast to loose pulleys, and "vice versa," I should advise doubling it, as the strain of starting up a machine to speed from "dead-rest" is very much heavier on the belt than that required to keep it in constant motion afterward. Belts should always be kept flexible, without being allowed to get "greasy," and there are various good dressings on the market for that purpose, the basis in general being neat's-foot oil, stiffened with a proper proportion of beeswax and resin, and applied with a brush "luke warm," or just warm enough to soften the stiffening, and well rubbed in. Hot oil of any kind should never be applied to a belt, nor should the surface be left damp or slippery. I have known large main belts in some of the cotton mills on the Merrimac River to do their work satisfactorily after 40 years of service!

I find on looking over what I have written that I have omitted to protest against the too common use of too narrow double belts. There are cases, such as on the cone pulleys of some heavy machine tool, where they may be advisable to economize weight and space in the head-stock of the tool itself; but I am decidedly opposed to the use of double 3 and 4-inch belts when there is width enough available to use a 6-inch pulley, and a single thickness of leather. A 6-inch belt, 1-6 of an inch thick, is as strong as a 4-inch belt of ¼ inch thickness, has a better hold on the pulley, and will usually outlast its lacings. A reference to what I have before said will show that there is less "disintegration" in the body of a single belt when used on a small pulley than in a double one.

I think this covers all I want to say in regard to belts and pulleys, but if I have omitted any points on which my readers desire information, I shall always be happy to give it to them, if I possess it myself.

There is another mode of pulley transmission now coming extensively into use, commonly known as "rope driving," which next calls my attention. Although useful in certain cases, and for certain purposes, which I will specify hereafter, I cannot admit that for steady, regular transmission in ordinary cases, when the distance from shaft to shaft is not over 40 feet, and the shafts are in parallel lines, it has any advantage in the point of economy over flat leather belts. It is true that the first cost is much cheaper than that of leather, but the durability is also much less, and as I have previously stated, I have known good leather main belts doing effective service after 40 years' constant use.

The use of a round cord or string, for the transmission of power to a spindle, is as old as history, and probably far antedates the use of a flat "strap," as our English cousins still call leather belts. They have always been in the habit of transmitting large amounts of power by shafts and gears, and never took kindly to the use of leather main belts, which were first introduced, to the best of my knowledge, by Paul Moody and Sam'l Batchelder in Lowell in 1828. When, however, rope transmission was fully established by "Hirn" in Germany, and its great advantage over shafts and gears fully shown, the English mill owners "tumbled to it" at once, as it did not shock their insular prejudices by being a "Yankee notion," and American visitors to English mills and shops, seeing its greater cheapness of first cost, soon introduced and recommended it in this country. For long reaches of over 40 or 50 feet, the superior lightness of a "rope drive" is no doubt a great advantage. It is also available for outdoor transmission, where exposure to the weather would render a leather belt impracticable, as the same composition which is applied to the ropes to keep them from wear on the surface also waterproofs them against damage from the weather. To my mind, however, the particular advantage which they offer is their adaptability to "drives" at any angle. There is no need of parallelism in the shafts, and by the use of properly situated "idler pulleys," the shafts may be used at right angles with each other if necessary.

The great difficulty which the writer has noticed in their use has been the tendency to use too small pulleys, and by referring to his previous remark in regard to the difference between calculated and actual speeds, caused by the thickness of belts, the source of this trouble will be seen at once. Let us take a 40-inch pulley, for example, which is the smallest size admissible for a one-inch rope. The length of its semi-circumference is 62.83 inches, which is the distance the inner surface of the rope would have to travel in going half round it. Now the outer surface would have to move the distance of the semi-circumference of a 41-inch pulley, or 64.40 inches, a difference of over 1½ inches at each revolution, and then as they came back to the stretch between the pulleys, both would have to recover their normal positions, or the inner surface would have to stretch ¾ of an inch, and the outer one contract the same at every revolution. Is it any wonder that driving ropes wear out and disintegrate under such conditions? This is especially the case with regard to Manila rope, each fibre of which is a congeries of finer fibres, united by a natural glue, and while the torsion of original fibres in the rope reduces the action of the strain from a direct lineal one to one of axial compression to a great extent, and the "dressing" applied to the ropes also tends to preserve them, the destructive action is there, all the same, and this is the reason why Messrs. C. W. Hunt & Co. and other makers of "rope drives" insist that no pulley shall be used of less than 40 diameters of the rope. I have seen cases myself where one-inch rope carried at high speed over a 24-inch "idler," has gone to pieces in 36 hours! With thin leather the case is different, and therefore, for very small pulleys I still recommend leather belting, as thin as possible.

* * *

## WEATHER WAS TOO DAMP.

*Editor* MACHINERY:

I send you herewith a clipping from one of the Harrisburg (Pa.) dailies. If you see fit, you may explain in the columns of MACHINERY "what sort of brasses these may be."

V. E. SHOPE.

### The Clipping.

Two more of the big "H-6" engines went through the city at an early hour yesterday morning on their way to a western road. The first to arrive in this city was the 1823 and it was only with great difficulty that it reached the roundhouse. The brasses of the oil cup were found to be warped and the oil would not lubricate properly. When the engine reached this city the journals were very hot. The engine went on, however, to Altoona, where it will be put in the shop for new brasses. No. 1824 followed several hours later, but was in first-class condition.

* * *

## A COMPARISON OF MOTIVE POWERS FOR AUTOMOBILES.

The great interest manifested in the evolution of automobiles makes the presentation of the following comparison of motive powers for these vehicles, by A. Fischer, in the first issue of the "Automobile," timely. How much of personal bias enters into the conclusions, the reader must judge for himself.

"Commercially, we need at present to consider but three systems of mechanical propulsion of road carriages—the electric, the steam and the gasoline engine. We read a great deal in the papers concerning the compressed air, carbonic acid-gas and liquid-air motors, but as yet nothing has been demonstrated in regard to them, except the ability of the promoters. The electric system is now being pushed by ample capital, has been extensively tried in this country, and we shall soon see whether it is destined to meet with success or failure in the limited field in which it can be applied.

"The steam carriage is now also being brought rapidly to the front. Aside from any questions of merit in this system, the laws of most states do not allow steam carriages on the streets of cities. The gasoline carriage has not as yet been pushed to the extent the system deserves, although it is the system that has made the automobile a success. In France the gasoline automobiles outnumber all others about 100 to 1. They are the only ones that have so far been successfully used for touring. It is the opinion of the writer that this will soon be so in this country. Below is given a synopsis of good and weak points of these systems.

"A short synopsis of the advantages and disadvantages of each system:

### ELECTRIC STORAGE BATTERY SYSTEM.

#### Advantages.

A rotary motor.

Absolutely no vibration.

Transmission of power from motor axle simple.

Easily manipulated.

Can be handled by almost any one with a little practice.

No heat.

No odor.

Motor can run in either direction at almost any speed from 0 to 1,000.

Driver can start carriage without any preparations.

#### Disadvantages.

Its limited range of action being about 20 to 40 miles radius from source of supply hence can only be used in large towns with a number of central supply stations.

Excessive weight of batteries, being out of proportion to load carried.

Lack of economy, being the most expensive of all systems.

Short life of batteries.

Cost per mile on pleasure carriage about 5 cents.

### STEAM.

#### Advantages.

Little vibration.

Transmission of power simple.

Weight moderate.

No central station required for charging.

#### Disadvantages.

Dangerous on account of the pressure in boiler.

Dangerous on account of use of liquid fuel used to heat boiler.

Boiler easily ruined by impure water.

Difficulty of management, requiring an engineer.

Discharge of steam on starting (frightening horses).

Length of time required to start—getting up air pressure, lighting torch to heat burners in getting up steam pressure.

Difficulty of keeping up enough steam pressure to supply engine.

Odors from imperfect combustion of oil.

Cost of operation about 3 cents a mile.

### GASOLINE.

#### Advantages.

Absolute safety.

No fire for engines.

Moderate weight in proportion to load carried.

Economy of fuel, about one-quarter as much oil being consumed for horse power as in steam.

The only system having an unlimited range of action. Gasoline and water can be carried sufficient for 300 to 500 miles' run. Can be used anywhere. No especial knowledge required for management.

Cost of operation about one-half cent per mile.

#### Disadvantages.

Some vibration.

Motors must be started by hand.

[To these disadvantages must be added: A variable speed device is required and engine must usually run when carriage is stationary. Also, a slight odor.—EDITOR.]

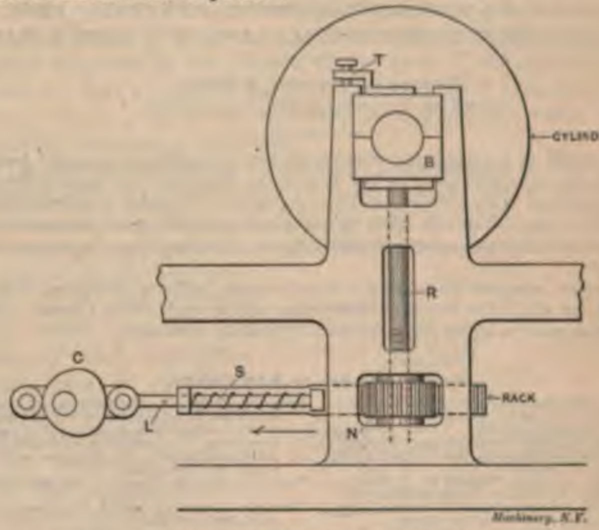
* * *

## A NOVEL MECHANISM.

There is no class of machinery better adapted to the study of the principles of mechanism than printing machinery. The motions that must be produced to ensure even impression of the paper on the type, the feeding and delivery of the paper, and the distribution of the ink; and the various other movements that must be accomplished, require such a multitude of cams, levers, gearing trains and other devices that the student will here find enough material for a long course of study.

Presses used for the best book work are of the type known as two-revolution presses. Their chief elements are a flat bed, on which the form of type is placed, and a cylinder around which the paper passes as it receives its impression. The bed travels back and forth under the cylinder once for every two revolutions of the cylinder and the latter always rotates in one direction. When the bed moves forward in the direction in which the cylinder is turning, the paper is printed and when the bed returns the cylinder raises out of contact with the bed so that there will be no interference while the motions of the two are in opposite directions.

It is a neat problem to design a motion that will raise and lower the cylinder at the proper times, since it must be held with absolute rigidity when in its lowest position, ready for the impression. The neatest solution to the problem that we have seen is that shown herewith, which is used on the presses upon which MACHINERY is printed.



CYLINDER RAISING MECHANISM.

The cylinder journals run in boxes, one of which appears at B, which are free to slide in a vertical direction between the jaws of the frame. The box is raised or lowered by a rod, R, which is threaded at its lower end for the nut, N. This nut is in the form of a pinion or small spur wheel, which bears top and bottom in the slot shown in the frame and is rotated back and forth by the rack R. The rack is operated through the rod L and the spring S by the positive motion cam C. Suppose the cam to move the rod L in a left hand direction or in the direction of the arrow. The pinion N will then turn in a left hand direction, as seen from above, causing the rod R and the box B to move downward until the thumb screw T comes in contact with the top of the frame. This prevents further motion of the rod R without breakage and the spring S then comes into play, stretching as much as is necessary to allow the cam to complete its rotation. The result of this is that while the cylinder is always locked rigidly in position by the nut, N, its motion can still be easily adjusted by the thumb screw T.

Most mechanisms used in printing presses for this purpose require a lengthening or shortening of the rod R in the adjustment of the cylinder, but in this case this source of inconvenience is avoided by the very ingenious combination of the nut N and the spring S.

* * *

## LOCOMOTIVES USED AS "SLUGGERS."

An English paper says that the locomotive as a weapon for assault and battery promises some novel situations to the novelist in search of new color for a thrilling work. At the Cyfarthfa Steel Works of Crawshay Brothers, near Merthyr Tydfil, are some locomotives having quite cantankerous engineers. The other day, one of the engineers, named Hopkins, left his engine to get coal. While thus engaged another engineer, named Edwards, came along and requested that the first locomotive should be moved away so that he could pass over the crossing to a water tank. Receiving refusal, he attempted with his engine to move the obstructing locomotive, whereupon Hopkins mounted to his place, put on steam, and drove the aggressive engine back. The latter then charged forward, but, according to the police court report of the subsequent proceedings, got the worst of it. A third charge, however, resulted in the engine driven by Hopkins being sent off the rails. Hopkins has been committed for trial for endangering the safety of the public, his defence being that he did not commence the battle. But there was a conflict—of a kind very unusual.

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# MACHINERY

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Lester G. French, Editor.
Fred E. Rogers, Associate Editor.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

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## OCTOBER, 1899.

## CIRCULATION STATEMENT.

The regular edition of MACHINERY for October is 17,500 copies. AMERICAN MACHINERY is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. No papers are sent free except to advertisers, exchanges and circulation agents

The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

| | |
|---|---|
| The IRON AGE, about | 7,000 |
| The AMERICAN MACHINIST, about | 12,000 |
| MACHINERY | 17,500 |

Owing to a typographical error, the run for September MACHINERY was stated to be 17,150 copies. It was 18,000.

* * *

## TECHNICAL PAPERS.

One of the serious drawbacks with machinists to-day is that they are tied down, not only to one town or perhaps one shop, but oftentimes to one part of one shop, and it is not always easy to make a change for the better. It is expensive to branch out and try experiments, and if it were not for the technical press too many would find that they were gradually growing out of touch with all that was modern and progressive. This is one reason why every mechanic should make it a point to read a mechanical paper. It will help him to advance, to get out of a rut, and to broaden his knowledge beyond the narrow horizon of his own experience. How many mechanics are there who could visit, even a single one of the great plants of the country like the famous Union Iron Works of San Francisco, which were illustrated in the last number of MACHINERY, or the works of the Bethlehem Steel Co., photographs from which appear in this number of the paper? How many are there who, even if they did visit shops like these, could have pointed out for them the novel and improved methods and could take notes for future reference?

Glancing through the files of MACHINERY, we estimate that not less than 1,000 shops in this country, Canada and Europe, have been visited by the editors or other representatives of the paper during the past five years for the preparation of articles; and there have also been hundreds of communications from readers upon practical shop experience. While much of this matter is not new to every mechanic, it is inevitable that some of it must have been new and of value to all. It is impossible for any one man to acquire in his own experience a knowledge of the methods and devices that have been developed only by the work of hundreds of men in different parts of the country. A mechanical paper must necessarily cover a wider range of work than one man is engaged upon. A man may, for example, be employed during his life time in engine building and have nothing whatever to do with the finer grades of tool work, or even with any other class of heavy machine construction. He would grow to be a very narrow and one-sided mechanic, however, if he sought only to obtain information that would assist him directly in the building of engines. The only way to become a mechanic with all-round good judgment and with the ability to take responsible positions is to become a many sided man as far as it lies in one's power to do so. No information can be absorbed from any source that will not be of indirect benefit in conducting one's special line of work. There is probably no factor so essential in making a well balanced mechanic of this description as are the technical papers. The thoroughness with which most of them do their work at the present time makes them indispensable to all who wish to advance in any department of machine construction.

* * *

## IRON VS. STEEL.

It is probably within the remembrance of even the younger readers of MACHINERY that the discussion as to the relative merits of wrought iron and steel for shafts, axles, crank-pins, etc., was conducted in nearly every technical paper. There was at that time a very good reason why there should be so wide a difference of opinion regarding the merits of these two materials.

Wrought iron is a ductile material that is easily forged, and when it is properly forged, it gives good results in actual service. It has an elastic limit of about 22,000 pounds and a tensile strength of 50,000 pounds.

At the time when steel was introduced commercially for forgings, it was made to conform as nearly as possible to the figures obtained with the best wrought iron, and as considerable difficulty was experienced in forging high-carbon steel, specifications usually called for a mild, ductile material of perhaps 60,000 pounds tensile strength and 30,000 pounds elastic limit, with an elongation of from 25 to 30 per cent.

Steel of this character is superior to iron for most forgings, but, as stated, it is not strange that there was a diversity of opinion as to the relative merits of each material. With the improved methods of steel manufacture, however, came the successful attempts with higher carbon steel and later with nickel steel, with the result that we now have forgings of both large and small sizes with a tensile strength of 80,000 pounds, an elastic limit raised to 50,000 pounds, and an elongation nearly as great as that obtained with the milder steels.

It should be borne in mind that what is desired is not so much a steel of high tensile strength, as one with a high elastic limit combined with ductility or toughness. When steel is strained beyond its elastic limit, the point of safety has been passed. Prof. Mansfield Merriman, of Lehigh University, has calculated that the shaft of the United States Steamship Brooklyn, which is 17 inches outside diameter and 11 inches inside, is as strong as a solid shaft of milder steel about 10 inches in diameter. This shows in a striking manner that there seems to be no longer room for argument as to the merits of high and low carbon steel or of wrought iron for important forgings.

* * *

A congress of specialists of all countries for the purpose of obtaining uniformity in the methods of testing materials of construction, is to be held, under the patronage of the French Government, during the Paris Exposition of 1900, from the 9th to the 16th of July. The unifying of testing methods is a question of great importance, and its solution is indispensable if, from the testing of materials, exact and incontestable results are to be expected, giving every possible guarantee.

# AMONG THE SHOPS.

## SOME NOTES ON THE MANUFACTURE OF HYDRAULIC MACHINERY, GATHERED IN THE SHOPS OF THE WATSON-STILLMAN CO.

The manufacture of hydraulic tools and machinery is properly classed as a separate business from ordinary tool manufacturing, as the peculiar conditions encountered in the constructon of machinery that is required to withstand an internal pressure varying from 6,000 to 30,000 pounds per square inch according to the service, call for methods and expedients in shop practice that are somewhat out of the ordinary.

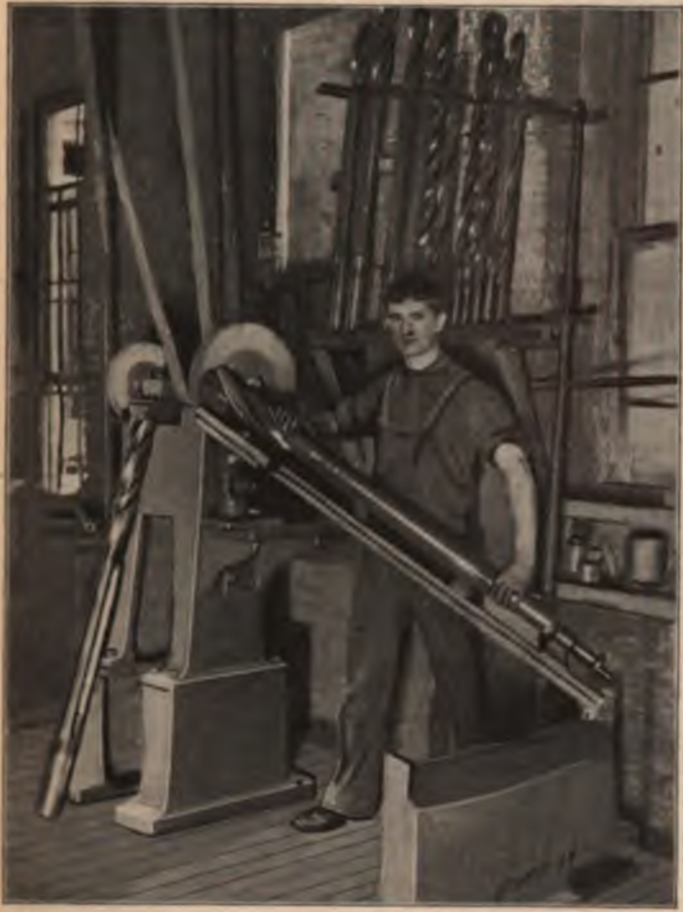

FIG. 1. GRINDING SOME HUGE TWIST DRILLS.

One of the well known firms that have for many years been engaged in the manufacture of hydraulic tools and appliances, is the Watson-Stillman Co., at East Forty-second street, New York City. Here in the heart of the city and in a rather small space when the extent of the business is considered, the writer found a shop that manufactures nearly seventeen hundred different tools, many of which, however, are built to order only. Nearly all of this large variety involves in some form an application of the displacement principle for obtaining heavy pressures and range from tools weighing a few pounds to presses weighing tons and capable of exerting enormous pressures. One of the notable tools in construction at the time of the writer's call is a draw-bench for the manufacture of seamless steel tubing which is over eighty feet long when the piston is extended. The limits of the shop do not permit the complete erection of this machine, but as the parts are made on the interchangeable plan, the complete shop erection is a minor matter. A cylinder of the length required by this tool is necessarily made in sections and the form of coupling used is shown in Fig. 2. The essential features of this novel form of coupling are clearly indicated in the cut, the ends of the sections having flanges beveled as shown at D over which fit the two halves of the clamp B B. The interior of these pieces is bored out to fit the tapered flanges and when drawn together by the bolts C C, the ends of the cylinder sections are drawn squarely together with a uniform pressure on all points of the joint which obviously is of great advantage when holding back heavy pressures.

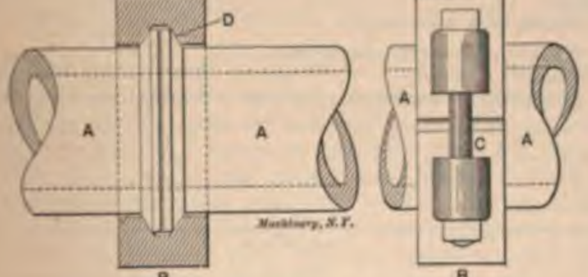

FIG. 2. HYDRAULIC COUPLING.

The piping and fittings for this and other presses are all tested hydraulically to a minimum of 6,000 pounds per square inch, and as much higher as the service may demand. The fittings are all steel castings and are threaded right and left as it has been found to be the best practice, which will undoubtedly rather overturn the ideas of many pipe-fitters who have a prejudice against the right and left forms of fittings.

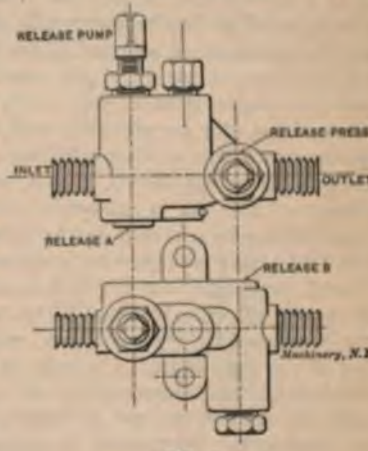

FIG. 3.

All materials entering into the construction of hydraulic machinery and tools must be of the best, especially when intended for heavy work. To obtain bronze castings which are uniformly free from porous places seems to be very difficult, and it becomes necessary in consequence to test the piece as the different operations are performed. The parts referred to are the pumps, valve cases and other fittings of a similar nature. While many of these parts, such as Fig. 3, are of a complicated nature as to the cavities and passages, it has been found most practicable in most instances to have such parts cast solid and then to machine out the various holes and valve cases from the solid metal. The practice is to test the part after each operation for porosity, and very often when the last operation is concluded, the final test will disclose a flaw that necessitates the condemnation of the part. It is not surprising, therefore, that hydraulic machinery and tools bear what might be thought to be a high price as the unavoidable losses from such failures have of course to be made good by an increased selling price.

One of the most striking features of this shop to the machinist is the use of abnormally large twist drills for chucking machine work. The grinding of one of the largest drills shown in Fig. 1, will give a better idea of the size than the dimensions, which are 3½" diameter by 4' long. As will be noted, these drills have oil conduits for carrying lubricant to the point of the drill, and provision is made in the machine in which they are used for a large supply of lubricant so that the temperature of the fluid may be kept at a low degree. The efficiency of these drills may be judged from knowing that over 300 cubic inches of mild steel have been drilled out in one hour. This involves a depth of 32" with a drill 3½" in diameter. Such a performance is, however, nearly double the regular rate, as the extra grinding and wear does not warrant it from an economical standpoint. The smaller hydraulic cylinders for the jacks and similar tools are drilled from the solid material, for although it is possible to obtain seamless tubing that may be superior in some respects to cylinders made from the solid, the cost is greater and the supply more or less uncertain.

The interior of the tubes is ground on a grinding machine which is worthy of notice, as it embodies a principle that is not used, to any extent at least, outside of this shop. The machine is built on the general lines of a lathe and the tube or cylinder to be ground is given a longitudinal movement by a carriage having two steady-rests which hold the work. Mounted in the spindle is a long supplementary spindle D, about 1½" in diameter, which carries the grinding head shown at C in Fig. 4. The head has three slots through which the pieces of emery stone A A project. The taper plug B and spindle are attached to the tail spindle by which the pressure of the emery pieces on the interior of the work may be regulated. The centrifugal action when the head is rotating at high speed is sufficient, however, to give quite a pressure, being ample usually for the finishing touches.

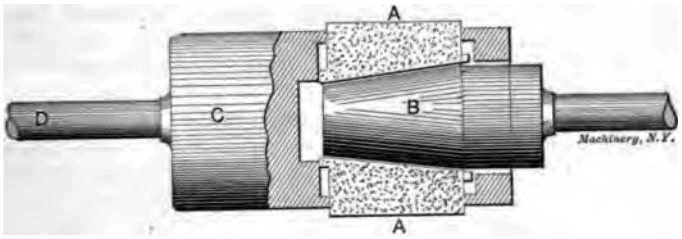

FIG. 4. INTERNAL GRINDING HEAD.

While boring machines of various types and makes are in use on the different classes of work, the boring of large steel tubes that require a smooth and accurate bore is done on an engine lathe which has been specially rigged for the purpose. This may be partially on account of the limited capacity of the boring machines at hand but the combination used in connection with the engine lathe is well worth a description, as by its use many shops may be provided with a good boring machine at a trifling cost. The work spindle has a hole large enough to allow the passage of the bar H, Fig. 5, which is about two inches in diameter. The bar is splined its entire length and is prevented from turning by a sliding feather attached to the thrust bearing. The feed is accomplished by a ratchet nut operated by the lever C, and the connection G which receive movement from a crank F on the end of the feed-rod. The thrust is taken by a ball bearing supported by the casting A, which is bolted over the back end of the head-stock. The tube being bored out is held in the lathe chuck and supported at the other end by a steady-rest, while the feed of the bar is toward the head-stock, thus putting the boring bar in tension as regards the effect of the feed. A packed bit is used with a constant stream of lubricant forced over the edges of the tool and another stream is directed on the bar at the head-stock to wash away the chips which collect in the threads and would clog the nut if allowed to remain. Provision has been made for a quick return of the bar when the end of a cut has been reached by slots cut in the nut and the end of the spindle which allow the insertion of a key, thus locking the two together. The ratchet being disengaged, the lathe is run backward at speed which rapidly forces the bar back through the spindle.

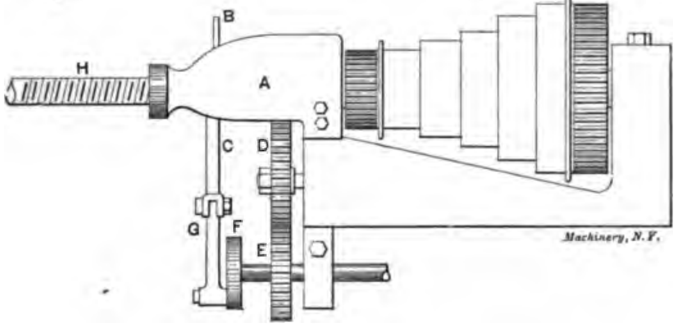

FIG. 5. ARRANGEMENT OF LATHE HEAD STOCK FOR BORING BAR.

The jack shown in the sectional cut Fig. 6 is reproduced from the Watson-Stillman catalogue, in which it is listed as a claw jack, but the essential features are the same in all the tools of this class, and in fact are practically the same in the other hand tools which operate on the displacement principle, as the great number of tools manufactured makes it necessary to have a standard form of construction for as many parts as possible. This being the case an explanation of the working of this jack will answer for practically all others of this company's manufacture, as well as those of other firms, with the exception of minor details. The writer has found in his experience that in many shops there is a surprising ignorance in regard to the principles and operation of these useful tools with a consequent helplessness when anything goes wrong with them.

Referring to Fig. 6 it will be seen that the piston or ram forms a reservoir for the liquid and that the lower part is a force pump for transferring the liquid to the lower side of the ram. The pump piston contains a valve with a long stem and the check-valve in the ram has a light coil spring which tends to keep it always to its seat. In operation the liquid in the reservoir is pumped into the space below the ram and as it cannot escape, the ram is pushed upwards with a force that depends upon the relative sizes of the ram and pump piston, the length of the lever and the effort expended by the operator. After the load has been raised to the desired point and the ram is to be lowered, the hand lever is turned over and forced to its lowest position. By this action the "lowering wire head," by reason of its eccentric connection to the arm, forces the sleeve downwards, which unseats the valve in the piston bonnet. As the piston is forced to its lowest position by the same movement, the projecting valve strikes the top of the check valve in the ram and allows the liquid to escape through into the reservoir and the ram to lower. It will be seen that there is nothing mysterious or difficult to understand in the operation or construction of a hydraulic jack, but they do require the best of materials in manufacture, good workmanship and some care on the part of the operator. The ram should be kept free from dirt, or if this is impossible, it must be carefully cleaned off before lowering into the cylinder to avoid scratching the bore. When necessary to replenish the filling, the liquid should be carefully strained before being poured into the reservoir. Probably the best filling for all around purposes is alcohol, as it will not freeze in winter or rust the cylinder. The practice followed in some quarters of using wood alcohol is condemned as its action is probably more detrimental to the leather packing than to the stomachs of the hardened characters who have been known to rob a jack of its life blood.

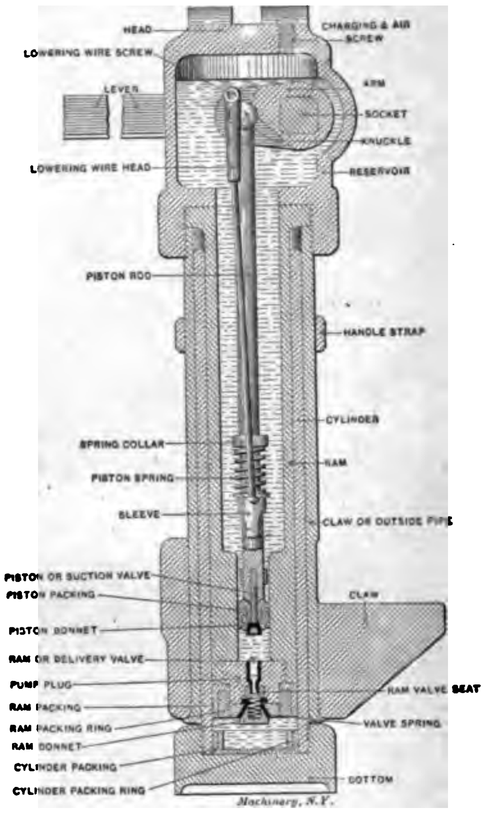

FIG. 6. DETAILS OF A HYDRAULIC JACK.

| F.<br>1. | THE WATSON-STILLMAN CO.<br>GENERAL INDEX. | Drawing No. D-122-134<br>Machine No. 1254 |
|---|---|---|

**Name**
Forging Press, 600 ton Hyd.
24" Ram. 4 ft. 0" stroke, 2500 lbs per sq. in.
**Remarks**
For 2½" and 5"—5 spindle Bal. Gov. Valve. See R-951-960

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Color, salmon.

FIG. 7.

The efficiency and safety of a hydraulic jack depends on the tightness of the valves and the cup leather packings in the ram, so the manufacture of packings that will give the best results is quite an art. The writer was shown formed packings of various sizes down to as small as ⅜" in diameter. The latter were made from leather 3-32" thick and had a depth of ½", which gives one a new idea of the extent to which ordinary leather can be moulded.

A very good system is in vogue in the drafting room for the preservation of drawings, tracings and blueprints which also gives a ready means of reference to the drawing of any machine or part. The drawings which are 18" by 27" outside and 16½" by 26" inside the border line are kept in manila covers with the distinctive titles and numbers of included drawings printed on the outside. For the safe keeping of the drawings and tracings, two safes are used, having sheet iron trays 19" x 31" x 1½" deep. One of these trays is usually sufficient to hold all the tracings of a class and have titles pasted to the front as "A—Plain Base Jacks," "B—Low Hydraulic Jacks," "C—Special Jacks," etc.

| | |
|---|---|
| THE WATSON-STILLMAN CO.<br>DRAWING NUMBERS. | Drawing No. D-128<br>Machine No. 1254 |

Name

600 tons Hyd. Forging Press.

24" Ram, 4 ft. 0" stroke, 2500 lbs. per sq. in.

Remarks

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..................................................................................

..................................................................................

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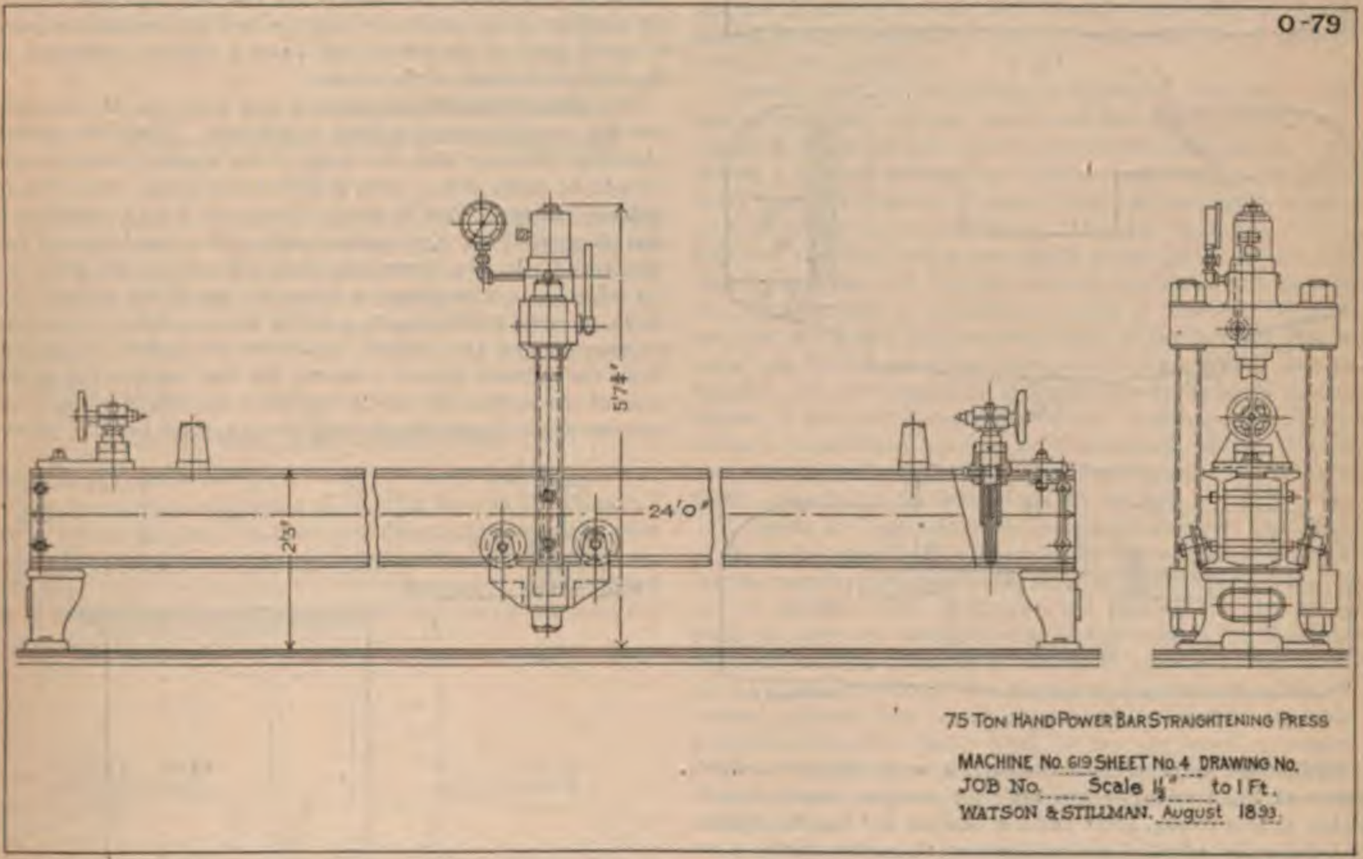
Color, light blue.

FIG. 8.

The card index system is used for the location of any drawing which is generally familiar to most readers as its simplicity and general convenience have recommended it to all in need of a simple index system. One of the individual cards and the general index card covering that class is given herewith, which also gives an idea of the variety and extent of work done by the firm.

The practice is being followed of photographing all tracings and taking blue prints 7" x 4½" from the negatives, which gives a very convenient means of showing a prospective customer the salient features of a machine without going to the expense of sending him a full sized blueprint. These small prints are also very convenient in the shop for the use of the foreman, who can thus readily refer to all the drawings of a class at any time without the trouble that attends the use of the full sized sheets. One of these small prints has been reproduced full size in Fig. 9, which shows that in this shape the eye can perceive the idea and general construction of a machine easier than in a large drawing.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24'0"
2'5"
75 TON HAND POWER BAR STRAIGHTENING PRESS
MACHINE No. 619 SHEET No. 4 DRAWING No.
JOB No. ____ Scale 1½" to 1 Ft.
WATSON & STILLMAN. August 1893.

FIG. 9. FULL SIZE REPRODUCTION OF A SAMPLE BLUE-PRINT.

## THE OLDEST IRON STEAMSHIP IN THE WORLD.

Of the United States steamer Michigan, on Lake Erie, which is the oldest iron steamship in the world, her commander, Lieutenant-Commander C. P. Perkins, gives the following particulars in "Cassier's Magazine" for September:

The vessel was constructed at Pittsburgh, Pa., in 1841-43; the parts were transferred to Erie, put together and launched on December 5, 1843. The original machinery, with the exception of the boilers, is still in her and in good condition. The vessel is an iron paddle-wheel steamer of 685 tons displacement; length of keel, 156 feet 4 inches; length between perpendiculars, 162 feet 6 inches; breadth of beam, 27 feet; depth of hold, 12 feet 5½ inches.

There are two inclined direct-acting engines. The paddle-wheels are of the usual radial kind, 21 feet 6 inches diameter, with 16 paddles, 8 feet long by 1 foot 4 inches wide. There are two steel boilers of the flue and return fire-tube type, 9 feet 6 inches in diameter by 15 feet 2¾ inches in length over all; two furnaces in each boiler, 6 feet 6 inches by 3 feet 6 inches in diameter, and have each a grate surface of 22.75 square feet. The total grate surface is 91 square feet, and the heating surface, 1,286 square feet. There is one smoke-pipe, 4 feet 4 inches in diameter, at a height of 42 feet 2 inches above the grates. Total weight of boilers, 47 tons.

There are five heavy box keelsons, which run the whole length of the vessel. The distance from centre to centre of frames is 24 inches; frames of T iron, 4½ inches by 4 inches; with reserve bars 4 inches by 2½ inches; keel plates, ⅝ inch thick; bottom and bilge plates, ⅜ inch thick; side plating and run aft, 5-16 inch thick; stem and stern posts, 6½ inches by 1½ inches; shear strake and plating carried up to the rail, ⅜ inch thick; deck beams are of T iron.

This vessel has been in continuous service to the present time over fifty-five years, and is apparently as good for service as ever. During all these years of service no signs of weakness were exhibited.

Her armament at the present time consists of six 6-pounders, two 10-pounder rapid-fire guns, and two machine guns. Of late years her principal occupation has been in the instruction of the United States naval militia at the different lake ports, and surveying.

# LETTERS UPON PRACTICAL SUBJECTS.

## ABOUT SHAPER SLIDES AGAIN.

*Editor* MACHINERY:

It was with considerable surprise that I read in the September issue of MACHINERY Mr. T. B. C.'s recommendation for the adjustment of the gibs of shaper slides. It would seem that this time-honored method of adjustment had sufficiently proved its inferiority as a reliable and durable device, although so extensively used as to be regarded by many as standard practice. It is unnecessary for me to point out its faults as they are only too well known to every machinist; and while T. B. C.'s method might be superior to that generally pursued, as it gives a more uniform adjustment, it is open to the same objections that render the ordinary form a non-reliable adjusting device.

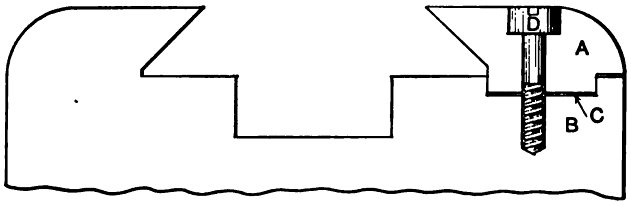


Fig. 1

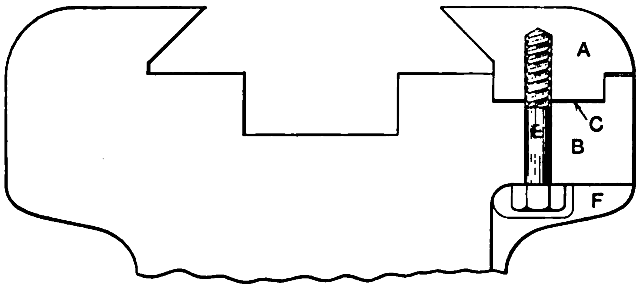


Fig. 2

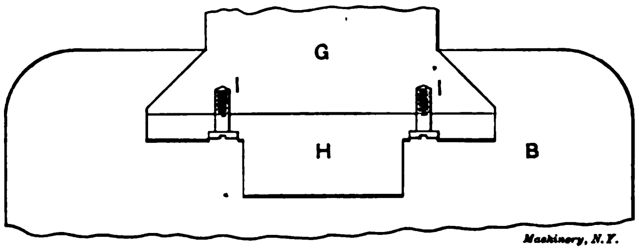


Fig. 3

While I am not a machine designer, it seems that the method shown in Fig 1 would be preferable for a shaper ram having V slides, as it is strong, gives uniform bearing and has the feature of being easily adjusted, which, however, the writer thinks is an objection. If a shaper is properly proportioned and built, there should be no reason for the continual tightening and loosening of the slides which is so much practiced. To overcome this objection the same method in its essential features for taking the slack is shown in Fig. 2, with the difference that the fillister head screws D in Fig. 1 through A into B are replaced by the hexagon head screws E in Fig. 2. The piece A is supposed to be drawn down solidly by the screws in each case, preferably without liners, which may, however, be used as shown at C. The heads of the screws are covered in Fig. 2 by the shield F, which should be fastened by a sufficient number of screws to discourage tinkering with the adjustment, but which could be readily removed in case it was thought to be really necessary.

The scheme shown in Fig. 3 is, in the writer's estimation, the winner of the three designs, and although not new, the principle is being used to a limited extent only in machine construction. The idea is to make the shaper ram G with a liner H fastened by the fillister head screws I I to the bottom and to take up the slackness due to wear by inserting liners between G and H. It is needless to say that no adjustment would be made until it was needed and when made it would very likely be done under the supervision of the tool-maker.

The making of machinery with this or similar adjustments is slowly coming into favor both with the makers and users of tools as it is reliable and unchanging. The boring machines manufactured by the Newark Machine Tool Works have it in a modified form on the cross-slide to the carriage and it is so protected from the machinations of the operator that it is necessary to take the table apart before any change can be made. The object sought is obvious, being to prevent undue slackness or tightness in this vital part of the machine. If the operator is allowed to manipulate the adjustment, he will almost invariably set up the screws after chucking a piece of work with the consequent result that the table is slightly sprung out of true, thus giving an inaccurate product.

F. EMERSON.

* * *

## ANOTHER NOVEL SHAPER DESIGN.

*Editor* MACHINERY:

I note in the August number of your paper that Mr. Emerson proposes to abolish the trouble incident to the upward spring of a shaper ram when near the extreme outward portion of its stroke by cutting off the slides of the ram near the head so that the moment of the cutting force of the tool will remain the same at every point of the stroke and cause a uniform deflection of the ram at all points of the stroke.

This idea is certainly a novel one and there can be no doubt but that it will accomplish what is intended. It has the serious objection, however, that the depth of the shaper column would have to be much greater with a tool of this design than with an ordinary shaper. This is shown clearly in Fig. 1, which is a reproduction of Mr. Emerson's sketch, with a few lines and figures added. In Mr. Emerson's design, in which the slides are cut off at A, it is necessary to make the top of the column of a depth, x, equal to the length, y, of the ram, in order to maintain an even bearing and uniform conditions throughout the stroke. With the ordinary shaper, however, the ram can overrun at the rear of the column by nearly one-third its length when at its extreme inward position and still have a good bearing, allowing the frame to be made of the proportions shown by the dotted line at a, and resulting in quite a saving in the cost and weight of the tool.

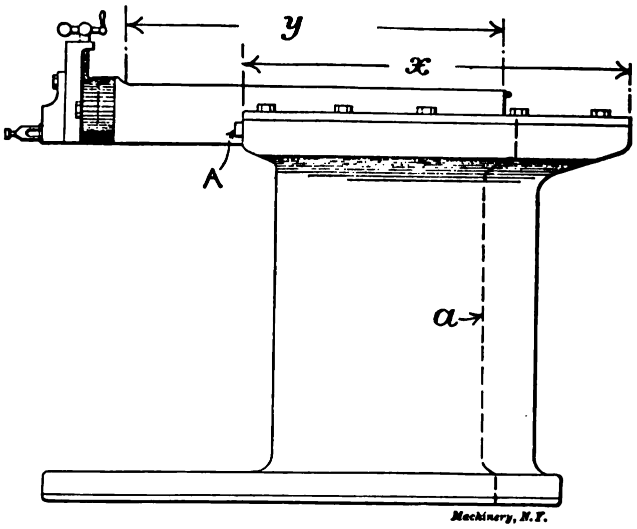


FIG. 1.

My suggestion is to adhere to the original design, so far as the arrangement of the slide on the ram is concerned, but to change the position of these slides from the bottom to the top of the ram, as shown in Fig. 2. In a shaper tool, as usually ground, there are two resultant forces to be overcome, as indicated by the arrows, one of which is in a horizontal direction, opposed to the movement of the ram, and the other is in an upward direction tending to spring the ram upward. The point A is the fulcrum or pivot about which these forces act and the upward thrust acts with a lever arm of length l, tending to move the outer end of the arm upward. With the arrangement of slides shown, however, the horizontal force acts with a lever arm h, tending to move the outer end of the arm downward.

With the arm fully extended the distance h would be less than the distance l, but this is compensated for by the fact that the horizontal force would always be greater than the upward force, making the moments of each balance nearly enough for practical purposes. Two driving gears should be used, one on each side of the central web of the ram and the driving racks should be on the under sides of the slides so as to bring the driving force and the slides as nearly as possible in a straight line.

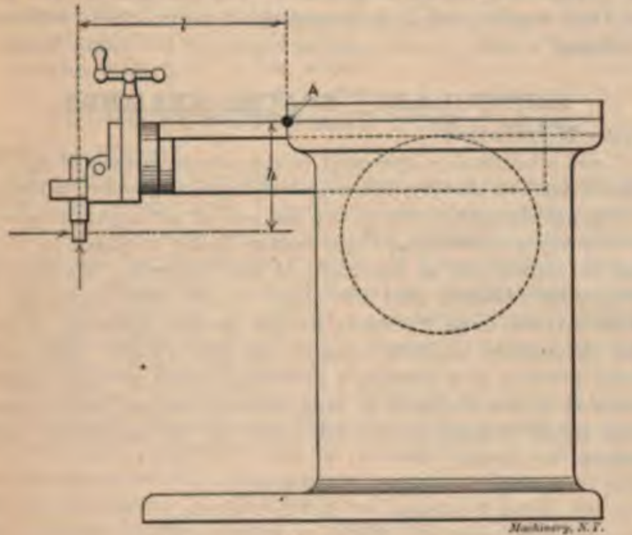


FIG. 2.

While Mr. Emerson's plan would accomplish the object sought, it is in the nature of a remedy rather than the removal of the cause. The spring of the ram would still be there, his remedy being simply to provide a means for making the spring uniform. By my plan the cause of the spring would be nearly or quite eliminated.

E. L. GRAY.

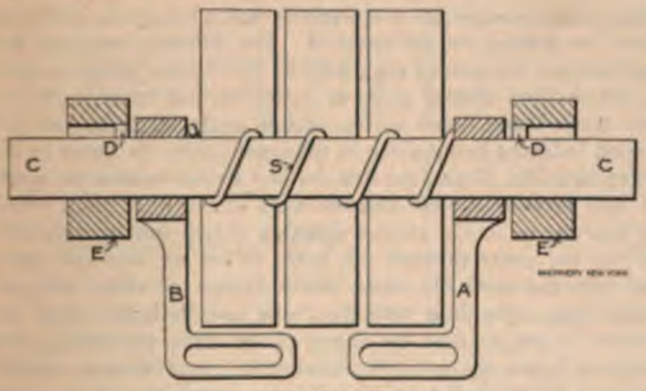
Westmore, Vt.

* * *

## A NOVEL BELT SHIFTER.

*Editor* MACHINERY:

In a recent visit to Beaman & Smith's shop in Providence I saw a belt shifter that was about the neatest device I have seen in this line. It accomplishes all that the complicated shifters do, with their cams and toggles, only moves one belt at a time and doesn't take a double width tight pulley in the centre as some do, or as the plain shifting belt always does.



BELT SHIFTER.

The sketch isn't quite correct, as the belt fingers A and B are not made as shown, but this gives the idea without making another view. The hangers E E have a square hole through them and a keyway for the feathers D D to work in. The shaft or rod C C is square and carries the feathers D D referred to before. The fingers A and B are cored square and fit loosely on C C. The spring S also fits loosely over the square rod and between the fingers, tending to keep them apart on the rod. Calling A the forward motion and moving rod C (by handle or lever) toward the left, the feather D carries finger A and the forward belt along to the tight pulley in the center, driving the machine forward. When the rod is released the spring forces A back to its own pulley. If a reversal is wanted the rod C is moved to right and belt A forced off the tight pulley before belt B can go on, the feathers D passing through hangers in either direction, but always carrying one finger or the other towards the center. The spring S is not a tight fit between fingers, only enough to keep the belt from working on.

I call this one of the neatest schemes I know of, and, best of all, I am told it isn't patented. I am going to use it first chance I get and presume others will do the same.

FRANK C. HUDSON.

Tombstone, Arizona.

* * *

## ABOUT THOSE EXAMPLES OF MANUAL TRAINING.

*Editor* MACHINERY:

In the August issue of MACHINERY I read with some interest and more apprehension the article entitled "Some Examples of Manual Training," by R. H. Smith of ———. Had I known his address I might have answered him directly, but it was not given, hence this letter. Another reason for making it public is that Mr. Smith gives the readers of MACHINERY a false impression of the manual training school graduate and appears to have an accurate impression himself which I wish to eradicate, if possible, without offense to any one. Being a practical mechanic, a pattern maker, a graduate mechanical engineer and an instructor of manual training and drawing I may without egotism assume to be competent to offer an explanation of the apparent failure of the apprentice.

It seems that Mr. Smith had an apprentice who was a graduate of a manual training school and who failed to solve some simple problems to Mr. Smith's satisfaction. He also has "observed a number of boys from different schools and in almost every case has noticed the same defect—an inadequate training or a woeful lack of confidence." This boy in the case cited, however, required only a few words to straighten out the difficulty in which he had become involved, and let us now examine the question from a metaphysical point of view. It is apparent that Mr. Smith was prejudiced against the boy and that his mind was in a negative condition concerning anything that the boy did. He was negatively inclined towards the boy's superior education and acted negatively either consciously or unconsciously towards him and thus influenced his mentality. The result was confusion and doubt in the boy's mind, a condition directly opposed to the best efforts on his part.

Thoughts are beginning to be recognized as forces and rightly so, as in this case the boy undoubtedly felt without understanding the negative condition of his superior officer's mind. By reason of prejudice that gentleman was looking for demerit instead of merit and imagines that it was found. He condemns on these isolated instances a system of education that in my mind is the salvation of the masses and a solution of the industrial problem since it puts reason and intelligence into labor. I would advise Mr. Smith when he has any more apprentices under his control to try and give them this faculty, he must give them a chance to prove their ability, as confidence is the child of experience.

Let us now consider some of the merits of the manual training school and its reason for existence. It does not attempt to teach a trade or profession, but is a school where the intellect is developed through the medium of things created. Manual training may and does direct the pupil to a proper selection of a trade or occupation. It teaches the principles and foundations of many trades and when the manual training student selects a trade, he does it intelligently, not because his parents choose it for him, but because he knows himself, a great knowledge, and he becomes a tradesman not a trades machine. Manual training schools bring forth the inventive faculties and nourish them; they educate the perceptions, the reason, the soul or mind.

A trade school, as its name implies, is a school where the pupil may be educated in some special branch of handicraft coupled with academic education, that will make him a skilled mechanic, a self-respecting citizen, an educated, therefore thinking man, not a trained automaton. To do this a broad education is necessary, morally as well as manually.

The shop man of to-day is a slave to ignorance and circumstances, perhaps narrower in some degree, than in the days of our fathers, because of the specializing of operations, the greed of the large shop owner and the creation of monopoly. What is its cure? Education—a broad education of the masses, that will make the man a skilled mechanic, and an intelligent voter.

Space does not permit me to discuss this problem socially, ethically and industrially as I desire to, so I shall give some of the results of manual training and trades schools taken from the "Eighth Annual Report of the Commissioner of Labor, 1892." "Out of 3,030 trade school students, from countries throughout the world, statistics have been made as follows: 908 began work with their employers as apprentices, 2,079 as journeymen, the balance not reported. In 2,628 cases out of 3,030, the employers prefer trades school graduates to those who have not had trades school education.

"The following shows some economic results: Out of 3,030 student workmen 2,071 were found superior to ordinary workmen in the use of tools, while only 324 did not have such superiority. In economy of the use of materials 2,138 were superior to the ordinary workmen, while 636 were not. In planning and arranging work 2,684 were superior out of 3,030, while 307 were not superior to the ordinary workmen."

I offer these remarks in justice to an education which I foster and in justice to the boy that Mr. Smith *had*. Do these statements, made by government investigation prove the manual training education "inadequate" and "with a woeful lack of confidence?" I think not.

L. A. BUCHANAN.

Stockton, Cal. Director of Manual Training.

* * *

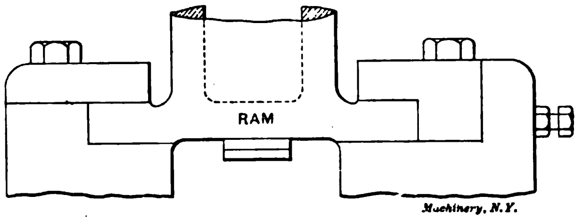
## DOES NOT LIKE "FREAK" DESIGNS.

*Editor* MACHINERY:

I am inclined to doubt the need for any marked change in established practice in shaper design, as suggested by two or three of your contributors recently. I admit that many shapers will not plane parallel on full stroke, but I am quite sure that there are some of standard design, without any humps, special slides or other devices or attachments, that will plane accurately and true full stroke. On one of these, for example, I recently saw a set of machine shop parallels planed that were true within half a thousandth throughout their full length, by actual micrometer measurement.

If the shaper ram is made heavy enough, it will not spring appreciably; and if the fit in the slides is close enough and long enough, there will be no appreciable inaccuracy from that source. This fitting ought to be done so well that the shaper will run when the slide caps are bolted down rigidly. If it is necessary to slacken the screws as T. B. C. mentions, of course the machine will not do good work.

My suggestions for improvement, therefore, are to make the ram heavy, to scrape the slides to an accurate fit before the machine leaves the shop and to make the wearing surfaces of the slides so generous that they will seldom—I might almost say never—need adjusting. These suggestions are along the lines of conservatism and good practice and I believe if acted upon will produce results superior to any of the more novel suggestions. It is at least certain that shapers built in this manner at the present time give good satisfaction.



PROPOSED SHAPER SLIDE.

Although the ram of a shaper is a moving part, there is not the objection to making it heavy that might be supposed. It should be remembered that while the kinetic energy of a moving body increases as the square of the velocity, it increases only directly as the weight, and a few pounds more placed where they will increase the stiffness will have very little effect on the power required to operate the tool. This is particularly true of crank shapers having a flywheel to alternately absorb and give out power at the end of each stroke. Beyond this, the added weight is an advantage, since it promotes steady action and eliminates chatter.

As far as the slides are concerned, a design like that shown in the accompanying sketch can hardly fail to give good results. There is nothing better than flat, square sliding surfaces. They are easy to construct, easy to adjust and keep in repair, and have less friction than angular surfaces. It always seemed to me, moreover, that thin steel gibs, set up with set screws, for taking up the wear, were about as poor an arrangement as could be devised. I much prefer heavy gibs like the one shown, which can be fastened rigidly in position. The thin gibs do not give an even bearing and it is impossible to adjust them uniformly from end to end.

OLIN SNOW.

* * *

## IRREGULARLY SPACED REAMERS.

*Editor* MACHINERY:

I was considerably interested in the scheme presented by Mr. Hayes for the making of irregularly spaced reamers, although it was not altogether new to me, but one of our apprentices who is at present in the tool-room became badly confused in reading the description as published in the September MACHINERY and rather doubted that the edges of the teeth could all be made of the same thickness by the second indexing. While the description is plain enough to one familiar with tool-room practice, it is perhaps a little hazy to the average apprentice and I have ventured to send you the diagram and explanation which cleared up the difficulties for the apprentice mentioned.

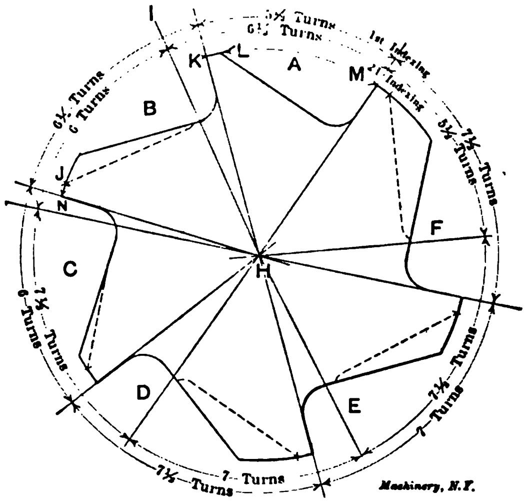


DIAGRAM OF REAMER.

Space A in the accompanying drawing is the first one cut and Hayes for the making of irregularly spaced reamers, although right for milling out the space B. The different indexings being followed through as suggested by Mr. Hayes brings us back to the original starting place at A, the various turns to the index crank being noted in the outside circle and those for the second indexing being given in the inner circle. As stated in the letter from Mr. Hayes, the first cut was started so that the width of land between the cut and the edge of the next tooth would be correct, so in the second indexing it will not be necessary to run the cutter through the space A but we skip one index and turn the crank 6½ times, which brings the cutter with the right edge, coinciding with the radial line I H, providing the reamer is cut so that the edges of the teeth are radial. The diagram is laid out with the distance K L equivalent in angular distance to one-half turn of the index crank thus making the width of the cut L M equal to five turns of the crank. In space B, the original index was 6½ turns, but by indexing 6½ turns for space A one turn in the angular distance is cut off so that the width of the cutter, which is equal to 5 turns of the index crank would leave only one-half turn between J and N, and remove the stock along the dotted line. In the same manner the equality of all the other spaces can be shown which is always a very good thing to do when presented with a new scheme as it is always cheaper to experiment on paper than in the shop with cast iron or steel. This explanation made the scheme so clear to the apprentice that it is safe to say that if he is given a job of the kind to do, he will not need any of my assistance to get him started right.

By the way, it seems to me that if there was more matter of an elementary nature published in the various mechanical journals, it would be a move in the right direction. There is a new crop of youngsters coming on the stage of action every year and they require education of the same elementary nature that was so acceptable to us ten or twenty years ago; but if the papers only publish that which will interest the older hands, the younger ones will have a rather dry time when reading up on their business. I would like to see more articles designed for the instruction of the apprentice and am willing to bet the price of a good hat that while the old heads may growl at it a little, they will read every word of it and get pointers, too. NEMO.

Providence, R. I.

* * *

## ORDER NUMBERS AND TIME CARDS.

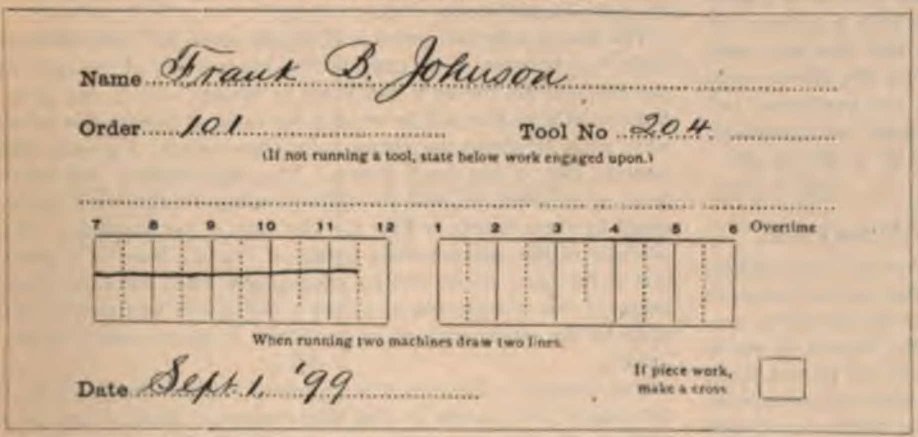
*Editor* MACHINERY:

The articles that you have published on shop management prompt me to offer a few suggestions about time keeping, principally with regard to issuing the order numbers for the different jobs and keeping the time cards. If a cost keeping system is to be of the greatest value, it should be so arranged that the cost of each operation on each piece can be obtained, if desired, and yet so flexible that it will not be necesssary to keep the cost in such detail if it is not desired.

The only way of getting the cost in detail, so far as I know, is to have the workman set down on his time cards the time taken for each operation, such as turning, boring, fitting, etc., and for convenience in filing I prefer to use a separate time card for each operation. If the time is not desired in detail, this can be arranged by the manner in which the order numbers are issued.

Suppose that a machine or a group of machines is to be built. The man who has them in charge should make out a complete list of all the parts of the machines, even to the screws and bolts, partly to facilitate ordering the castings and looking over the stock to make sure that there are no parts lacking, and partly to assist him in determining what parts he will wish to obtain the cost of after they are completed. If the machine is one that has been built regularly, it may be sufficient to obtain the cost of groups of pieces like those of the headstock or tail-stock of a lathe and all the parts of each of these groups would then be given the same order number. Or it might be sufficient to know the cost of the machine as a whole, or the lot of machines, in which case they would all go under one order number.

REPRODUCTION OF TIME CARD.



Name Frank B. Johnson

Order 101 Tool No 204

(If not running a tool, state below work engaged upon.)

7
8
9
10
11
12
1
2
3
4
5
6
Overtime

When running two machines draw two lines.

Date Sept 1, '99

If piece work, make a cross ☐

On the other hand, if it were desired to know exactly what each part cost, or any particular part cost, as would be the case with a new machine, or if new jigs or improved methods were being tried, the part or parts should have separate order numbers. The idea is to depend upon the order numbers for the sub-division of the work instead of relying upon the workman to designate the various pieces that he has worked upon. This makes it necessary for the foreman, draftsman or whoever places the shop orders to give the matter a little conscientious study before the work is given out, which is a good thing.

In brief, all the work of the shop is done under order numbers. If the costs are wanted in detail, all the pieces are given separate order numbers. If the costs of groups of pieces only are wanted, then the groups are given order numbers and the returns will show the costs with greater or less detail according to whether a large or small number of order numbers were assigned.

The sample card below will show what part the workman plays in the system. We will suppose that he is working upon order 101, and is milling. He works from seven to half-past eleven at this, and the number of his milling machine is 204. He writes on the time card his name, the order number, 101, and the tool number, 204. He draws a line from 7 to 11:30, as indicated, to show the time and finally adds the date. It is much easier for a workman to draw a line indicating his time in this way than to have to figure up the number of hours worked. The tool number will indicate to the time clerk that his operation was milling, so that it is unnecessary for the workman to write the operation unless it is some such work as fitting, where there can be no tool number. If he is engaged on piece work he places a cross in the square at the lower right hand corner and if he is running two machines he draws two lines to indicate his time, instead of one. At 11:30 he is given another job or else starts on another operation on the same piece, and when that is finished he makes out another time card.

A convenient way of filing time cards is to have a row of small paste-board boxes in the office, such as are made by the Library Bureau, Boston. These boxes are of the right size to hold cards 3 by 5 inches, which is a convenient size. Each box should have an order number and the boxes be arranged with their order numbers coming consecutively. All the cards of one order number are placed in the box of that number and when a job bearing an order number is completed, the cards are removed from the box, and the box is given a new number. All the boxes back of this one are then moved up one and this box is placed at the foot of the line ready to receive time cards when its new number is issued.

Having each card represent one operation, it is possible to group the cards in the several boxes according to operations, the workmen's names, or the tool numbers, according to what information is wanted. Also, this information can be obtained very easily and quickly by any one.

With regard to numbering the tools in a shop it should be said that there is a decided objection to the usual method of doing this. Numbers are generally applied without regard to any particular system, new tools being numbered consecutively as fast as they are purchased. Unless one is familiar with the tools, it is difficult to remember what ones the different numbers designate; and even whether the numbers designate lathes, planers or what not. It would be a very simple matter to number lathes with numbers from, say, 1 to 500, milling machines from 500 to 600, planers from 600 to 700, grinders from 700 to 800, etc., reserving a sufficient number of numerals for future additions to each class of machines. Each class of machine would then come under its own numerical group and it could be told at once what kind of a machine any number designated. Then, as to which particular machine was meant, it could be judged somewhat by the numbers, because the newest machines would have the highest numbers. WILLIAM B. CHAPIN.

Boston, Mass.

* * *

## A KINK FOR THE GRINDING MACHINE.

*Editor* MACHINERY:

Having been somewhat of a rover in the past, I have worked in the best as well as the poorest equipped shops in the country and have learned the valuable lesson that if up-to-date tools are not furnished, do the next best thing and use those which are at hand. The instance which I will recite occurred when I was employed in the gauge room of a shop that was at that time building bicycles. While all the tools were in the most wretched order it was the same old story of just as good work being expected from them as though they were up-to-date in every respect. I had not been in the shop long when the foreman came to me with a half-round broach 21½ inches long and ¾ inch in diameter with teeth ⅛ inch in width and depth. The broach was cut with teeth the entire length, and the round part had been ground on a universal grinder in the grinding room, but the flat part could not be done there, which was the reason for bringing it into the gauge room. As stated before, the job was given to me, and the foreman, with a wave of his hand, said: "You can do it on that grinder." The machine proved to be a surface grinder of modern design, but had received hard usage. I looked the machine over, but could discover no tools that were suitable for the job in hand. Being at the time a new man in the shop and having recommended myself as a first-class workman, I was naturally very anxious to hold the reputation, so I studied the situation for a few moments and decided on a plan which was thought would work satisfactorily. The table of the machine was carefully cleaned off and the broach laid on it in the position required for grinding. The foreman was then asked for some beeswax, but was informed that he had none, but that it could probably be obtained in the pattern department. Having secured the wax, it was put in a small ladle, and, having found a convenient gas-furnace, I was ready to begin operations. During this time I became aware that the foreman and the other machinists were closely watching me but I did not become "stage-struck" although the further the experiment proceeded, the more skeptical I became as to the final result. Having melted the wax it was poured on the grinder along each side and at the ends of the broach, the operation being continued while the wax hardened until the broach was molded in a bed of wax. It is needless to state that at this stage the room was well filled with smoke and that I was the center of curiosity. The emery wheel then received attention and was put in good order, by which time the wax was hard enough to commence grinding. No trouble was experienced in the grinding operation, and when completed the wax was easily removed. Upon calipering the broach with a micrometer it was found to measure the same throughout the entre length. The job was returned to the foreman and I must say that he exercised remarkable care in the examination of work if the scrutiny that the broach received can be taken as a sample of his inspection.

The writer remained in that shop for some months afterwards, and it is safe to say that beeswax could be found in every tool-chest, as no equipment was considered complete without it after receiving the little object lesson as to its possible use.

A. F. HORTON.

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## HEARD FROM.

*Editor* MACHINERY:

In a recent issue of MACHINERY I noticed an inquiry from Mr. Hugh Hill, of Anderson, Ind., for the present location of a gentleman who called on him some years ago with a process for converting wrought iron and malleable iron into fine tool steel, together with a collection of samples showing the effectiveness of the process. I wish to state that I am the gentleman and that anyone who is interested in such a process, can communicate with me at the following address. W. J. MILES, JR.

Middletown, Ohio.

* * *

## ELECTRICAL PROTECTION OF SAFES.

In a paper read before the Chicago Electrical Association Mr. Clyde J. Coleman gave a description of the various means in use for the electrical protection of safes. He divided these systems into open and closed circuit systems, the former of which is but little used except in residences, where it has proved more of a nuisance. The commercial systems of electrical protection are all based on the closed circuit. Among the means mentioned for protecting premises are cementing narrow tinfoil strips on the inner surfaces of window glass so that any breakage or fracture of the glass will open the circuit; the use of glass tubes filled with mercury and connected in circuit, or tubes filled with water or compressed air, or the maintenance of a vacuum in a partition or enclosure, any disturbance from an abnormal condition resulting in an electric alarm being given. A good method is the use of wires kept under a definite state of tension by a spring, any increase or diminution of which will allow an arm to touch a contact point, thereby sounding an alarm. In reply to questions by members as to the use of electricity in perforating safes, it was stated that a five-ply chrome steel safe 3½ inches thick was pierced with a current of 120 amperes and 80 volts at the arc, in 20 minutes; with 175 amperes in 16 minutes, and with 300 amperes in 3 minutes. A five-ply safe of the same material 7½ inches thick was burned through by 300 amperes. A 3½-inch Corliss was burned through by 400 amperes in 1½ minutes.—"Electrical World."

## TOGGLE-JOINTS.

### AN EXPLANATION OF THEIR PRINCIPLES OF OPERATION.

RETSEL.

The toggle-joint, while one of the simplest mechanisms to construct, is quite as difficult to understand as many of the more complicated movements. In Figs. 1 and 2 are shown the two simplest forms in which the toggle-point appears. In the first instance the force is supposed to be applied at F to overcome a pressure at P. In the second figure the right-hand arm is extended so as to form a handle to which the force is applied in a direction at right angles to the arm.

It should be noted that while this mechanism is called a "toggle-joint," it is really nothing more nor less than a crank and connecting-rod, of which the cross-head is at P and the connecting-rod from P to F, the right-hand arm corresponding to the crank.

The problem is generally to find how great a resistance at P will be overcome by a force applied at F; and as the resistance that can be overcome at P for a given applied force increases, as the two arms approach a straight line, no calculation can be made until the positions of the arms are known.

### Instantaneous Center.

All cases of the toggle-joint can be easily solved by what is known as the principle of instantaneous centers. This principle is simple and is clearly illustrated in Figs. 3 to 6, which apply to the two forms of toggle-joint shown in Figs. 1 and 2.

In any machine, simple or complex, no matter what its construction, the force applied, multiplied by the distance through which it acts, must equal the resistance overcome by the machine, multiplied by the distance through which it is moved. The principle of the instantaneous center affords us the means of finding the relative distances moved by the points where the force is applied and the resistance overcome.

In Fig. 3 ad and cd are the arms of the toggle-joint. What we call the instantaneous center is at o. It is located at the point where the perpendiculars to the lines along which the two ends of the arm ad move, this being the arm upon which forces F and P act. Thus, the end a moves in a horizontal line at right angles to line ao, and the end d, which is guided by the arm cd, and travels about the center c, moves for the instant at right angles to line do. The point of intersection, o, of lines ao and do is the instantaneous center.

The reason why this point is given the name of "instantaneous center" is because, if we consider the movements of the ends of the arm and the forces F and P for an instant, that is, for an infinitesimal time, they will be exactly the same as though the forces were rotating about the center o for that instant. To make this clearer, Fig. 4 has been drawn. This represents a bell-crank lever with arms eo and ao corresponding to the lines designated by these letters in Fig. 3. The axis, o, corresponds to the position of the instantaneous center of Fig. 3. Now it is plain, that if the lever be moved an exceedingly small distance about center o, the movements of points e and a will be precisely the same as the movements of forces F and P in the actual toggle-joint.

For example: Suppose it were found that for the position of the toggle-joint shown in Fig. 3 a downward push of .001 inch at d produced a movement at a of .002 inch. Also, suppose the lever in Fig. 4 to be constructed as directed, with the center-lines of its arms corresponding to eo and ao in Fig 3. It will then be the case that a downward movement of .001 inch at e will move point a .002 inch, just as in the toggle-joint.

Since the movements of the extremities of the two arms of a lever are proportional to the lengths of the arms, it makes the calculation of any toggle-joint very simple to first find the instantaneous center about which an equivalent lever may be assumed to turn, and then make the calculations as though based upon the lengths of these lever arms.

### Illustrations.

Basing our calculations, now, upon the respective lengths of the lever arms, it ought to be clear from the reasoning given above, or even without that reasoning, that if the lever in Fig. 4 is in balance the force at e multiplied by the length of the arm eo will equal the force at a by the length of the arm ao. Returning to Fig. 3, this is equivalent to saying that $F \times eo = P$

$\times$ ao. To locate point o conveniently, erect at point a the perpendicular to the direction of force P, and continue cd until it intersects the perpendicular at o.

Transposing our formula, we now have

$$\text{Force } P = \frac{F \times eo}{ao}$$

When, as is often the case, the two arms of the toggle are of equal length, then eo will be equal to one-half ac, or ab and ao will equal twice bd. Substituting h for bd (in Fig. 1) and l for ab, we shall then have, for a toggle-joint with equal arms, like that in Fig. 1.

$$P = \frac{F \times l}{2 \times h}$$

Referring to Fig. 2, this case is best solved by first neglecting the handle F and assuming the toggle-joint to be composed of the linkage afc as in Fig. 5. Here the force f acts at right angles to the arm cd. It rotates about the center o with a radius fo and P rotates about o with a radius ao, as indicated in Fig. 6. Therefore, f $\times$ do = P $\times$ ao. Or,

$$\text{Force } P = \frac{f \times do}{ao}$$

With equal arms, do will equal dc = r in Fig. 2 and ao will equal 2 $\times$ h. Hence, for equal arms, as in Fig. 2,

$$P = \frac{f \times r}{2h}$$

Now, taking into account the increased leverage afforded by the handle, with the force acting at F, we have f $\times$ r = F $\times$ R. Or,

$$f = \frac{F \times R}{r}$$

Combining this with the equation above, the effect of force F upon P is found to be,

$$P = \frac{F \times R}{2h}$$

### Double Toggle-Joints.

In most presses in which a screw and toggle-joint are used, the latter is usually made in the form of a double toggle-joint, as shown in Figs. 8 and 9. The question is often asked whether such an arrangement is twice as powerful as a single joint, and to make this point clear let us first take up the joint and screw of Fig. 7.

Assume for illustration that the two arms are of equal length and at an angle of 90 degrees with each other and that a force F of 100 pounds is applied by means of the hand-wheel. With the proportions and position assumed, it is evident that a small movement of the joint at F will produce twice as much movement at P and consequently only half as much resistance, or 50 pounds can be overcome at P.

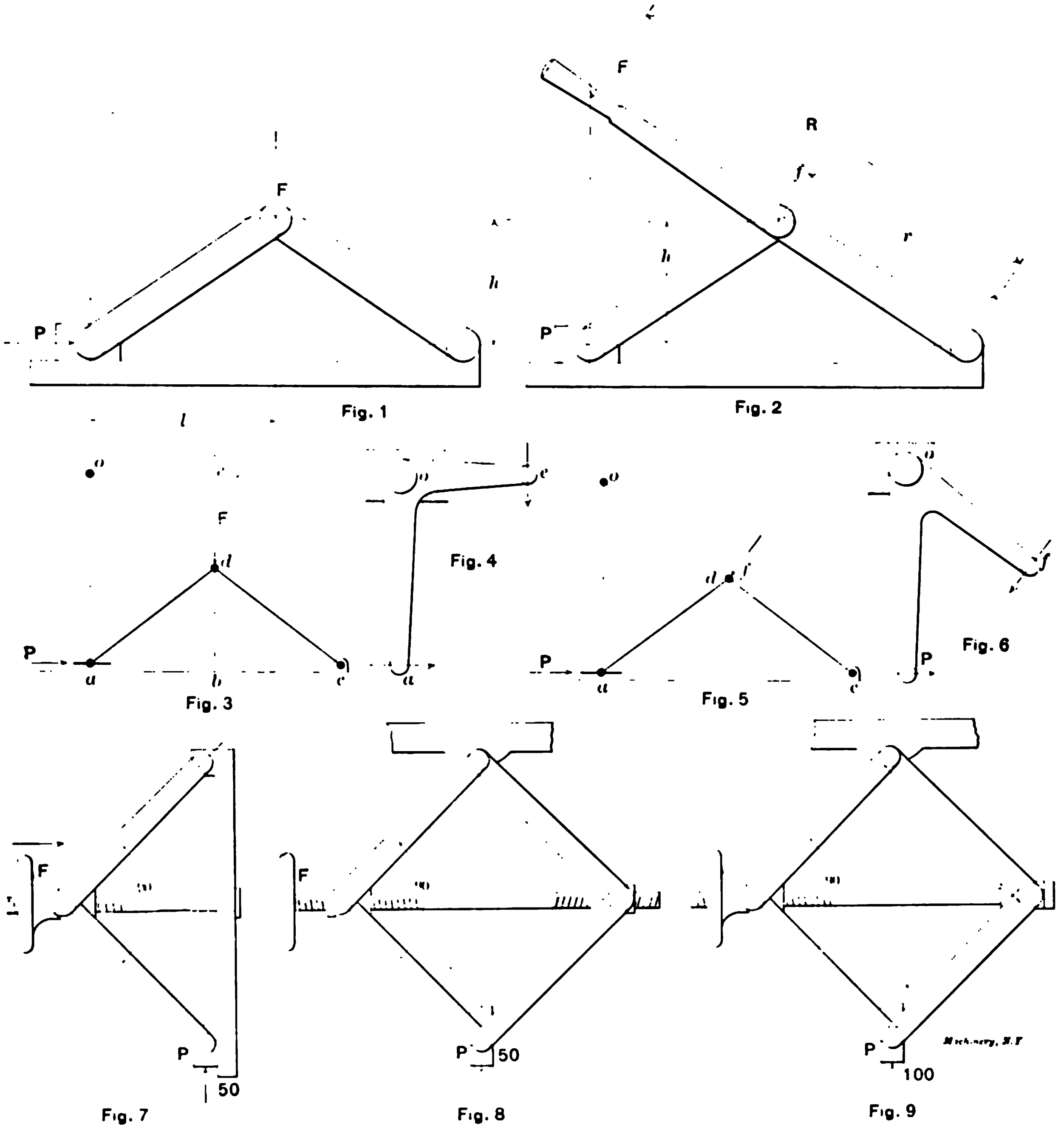


Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6 Fig. 7 Fig. 8 Fig. 9

DIAGRAM ILLUSTRATING THE ACTION OF TOGGLE-JOINTS.

In Fig. 8 the same proportions and positions of the parts are used as in Fig. 7. While the action of these different joints can easily be demonstrated, whatever the proportions, it is simpler to take the positions shown, because the relative movements of the parts can be seen at a glance.

In Fig. 8 a right and left-hand screw is used of the same pitch as in Fig. 7 and one turn of the hand-wheel will therefore advance each one of the toggle-joints and also the point P just as far as the corresponding parts were advanced in Fig 7, and no farther. It will therefore take just the same pull on the hand-wheel to overcome 50 pounds at P as in Fig. 7, but as each joint takes half the strain, there will be only 50 pounds tension in the rod between the joints instead of 100 pounds as before.

In Fig. 9 the case is somewhat different. Here the rod is threaded at one end only, of the same pitch as before, and the hand-wheel screws on the threaded part, drawing the two parts of the joint together. One turn of the hand-wheel will advance the hand-wheel itself a distance, relative to the screw, equal to the pitch. Each side of the toggle-joint will be advanced a distance equal to half the pitch and point P will be moved twice this amount, or a distance equal to the pitch, or the same distance that the hand-wheel moves along the screw. Hence, if the hand-wheel produces a force of 100 pounds a resistance of 100 pounds can be overcome at P, or twice as much as in Fig. 7. The stress in the rod will, of course, be 100 pounds.

To summarize, one inch horizontal movement of the hand-wheel in Fig. 7 will produce two inches movement at P; one inch movement in Fig 8 will accomplish the same result and hence the resistance overcome will be the same; but one inch movement of the wheel in Fig. 9 will produce the same movement, or one inch at P, and this form of toggle-joint has twice the power, but half the motion of the other two.

* * *

## THE "STRAIGHT EDGE" WAS CROOKED.

The "American Machinist" says in a recent issue that "A true story is told of a man who had a good stream of water running through his farm, and having heard of the wonders of a turbine water wheel, concluded to build him a mill. Having a nice level place by the creek, he built the mill. Finding out how much power he wanted and consulting the catalogue, he found that a certain size wheel at 22 feet head would do the business, and getting the guarantee that the wheel would work just as well under water as above, he proceeded to dig a well 22 feet deep, and put his wheel at the bottom of the well. It wasn't long after that he had a mill for sale and a water wheel to scrap.

An instance is known to the writer which, although not as absurd as that quoted above, still shows a degree of asininity scarcely credible. The owner of a small flouring mill had by economy and the labor of years accumulated quite a comfortable fortune and his business having increased to a degree that overcrowded the capacity of the old mill, he decided to build a new one on a site which promised greater advantages both for water-power and general location. Being of a somewhat parsimonious disposition, he begrudged the expense of hiring a surveyor to take the levels and give him the proper location of the dam and mill, so proceeded to do it himself. The site of the new dam having been chosen, the grade of the race and the height of the overshot wheel were determined by sighting along the edge of a sixteen-foot hemlock which had been located in a horizontal position by an ordinary carpenter's level at the low water mark of the dam. As it proved, however, the hemlock board was far from being an ideal straight-edge and after the mill was completed it was found that the top of the wheel was higher than the level of the dam. As the water persistently refused to flow uphill, the venture was a total failure and eventually ended in the financial ruin of the amateur engineer.

* * *

Most mechanics have their hobbies and a very common hobby among them is to devise a self-oiling loose pulley. There have been hundreds of different designs for them and it would doubtless be interesting to many if a few readers who have made successful loose pulleys were to send us descriptions of them for publication.

## SHOP KINKS.

**A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.**

**Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.**

### A RIG FOR CUTTING LONG RACKS ON THE MILLING MACHINE.

Our contributor "G" sends a sketch and description of a rig that was recently used in his shop for cutting ratchet teeth in some long steel strips. The strips being of such length that it was necessary for them to project by the column of the machine, the rig shown in Fig. 1 was made for the job. The part D is of circular section and has a slot cut out as shown for the train of four brass gears E E E E, which transmit the motion from the main spindle to the supplementary spindle on which the cutter H is mounted. The bracket C, which is bolted to the table, has a babbitted hole through the upper part for the passage of D. The part D fits freely in the babbitted hole, which is necessary for the movement of the table when feeding across the strip I. With this simple rig the teeth were cut without trouble by alternately cutting as many as the transverse movement would allow and then shifting the strip across the table a distance equal to its transverse movement.

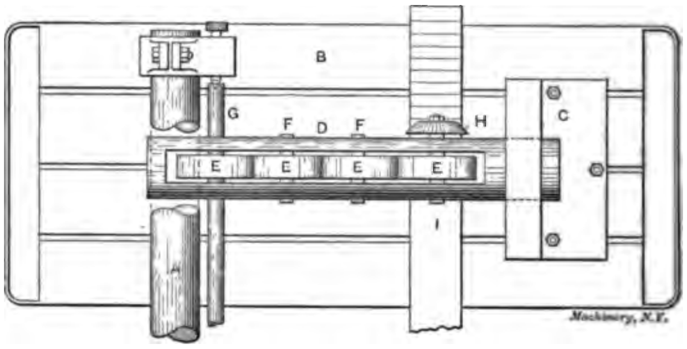


FIG. 1

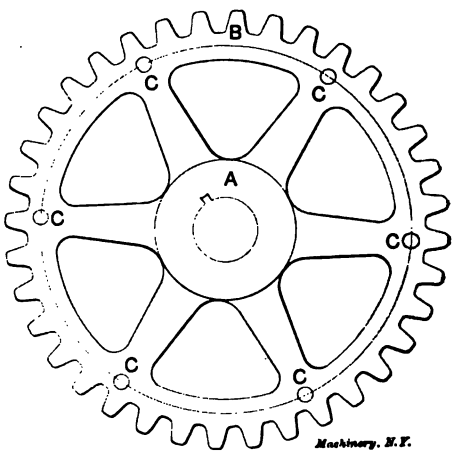


FIG. 2.

Another scheme that may be of interest was that used in the repair of a cast iron gear several inches in diameter which had a number of teeth stripped off. The repair being a rush job, it was decided that it would be quicker to fix it in the following manner. The gear was mounted on a mandrel and turned off to about one-half an inch below the roots of the teeth. A ring bearing gear teeth was cast of brass and bored out to a perfect fit on the old gear which had been turned down. The brass gear ring B, Fig. 2, was pressed on A and then holes C C, etc., were drilled one-half in each part, which were tapped out. Screws were put in and cut off flush with the face of the gear which thus prevented the ring from working off. Although made in a hurry, the repaired gear is running yet and doing good work.

### A SCRATCH GAUGE WITH MICROMETER ADJUSTMENT.

The simple form of scratch gauge having a fine adjustment is given to us by "J. E. S.," of Harrisburg, Pa., who claims it as his own design. From the sketch, Fig 3, and the description, we think that it may be a good design and one worthy of attention. The bar A is graduated from the end bearing the marking point F, which is rather peculiarly constructed, being a piece of square steel about 3-32 of an inch thick and sharpened from one side chisel fashion. The slot in which it is held is milled across the end, a hole having been drilled and tapped previously for the screw C, which being of larger diameter than the width of the slot, has enough thread to hold the marking point securely. The graduation starts from the bottom of the slot so that when the marking point is ground correctly, no allowance need be made as the distance between it and the first graduation will be zero. The sleeve B is threaded for the part E and has two slots sawed in for about 1 inch, thus forming the tongue C in which the set screw D is threaded. To use the tool, the sleeve B with the knurled part E is shoved up to the approximate position and then the screw D is turned slightly to secure B to A. The effect of the screw is to lift the tongue D with its threaded end into the threads of E and to thus produce some friction but not enough to prevent its turning for the final adjustment which is effected by turning E until its outer edge just coincides with the graduation desired. A final turn of the set-screw locks the two parts together when the tool is ready for use. The thread on B may be cut 25 to the inch and with 20 radial lines on the right face of E together with a longitudinal line on A, adjustments may be increased or diminished by five-hundredths of an inch or thousandths may be estimated.

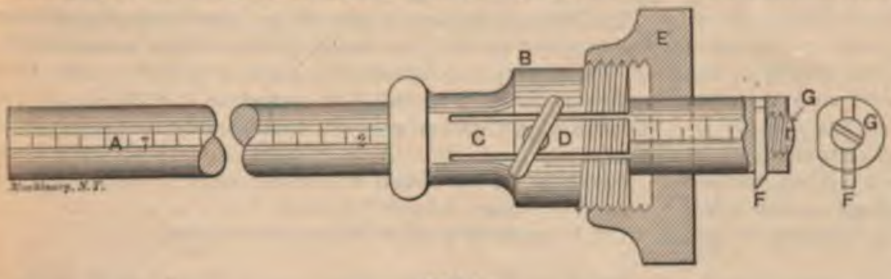


FIG. 3.

### CHISEL FOR CHIPPING STEEL.

A New York machinist says that a cape or round-nose chisel ground as shown in Fig. 4 forms a useful tool for removing tough hard steel as it will not break and has not much tendency to gouge in or to jump out. He found it useful on steel shafts which were to have a number of feathers sunk to a depth of 5-16 inches, the feathers being about 4 inches long and 1 inch wide. The keyways for the feathers were laid out and then four 1-inch holes were drilled with a flat end drill to the required depth. An attempt was made to cut out the metal between the holes drilled but the steel was nearly as hard and tough as the chisels, which made the chipping very difficult and discouraging.

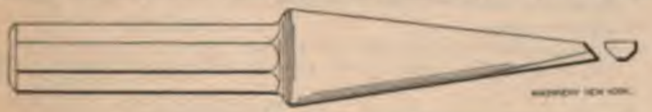


FIG. 4.

After a number of chisels had been spoiled, the scheme of grinding one as shown in the sketch was tried and found to work very successfully. Of course it could only be used as a stock-remover and not for finishing the key-ways, but as the principal breakages occurred when taking out the thick part of the intervening walls, this tool saved the finishing chisels.

He says that the same form of chisel has proved of value in removing a heavy section of wrought iron when necessary to surface off by hand a portion of a rough forging. On the latter work cross cuts are driven to a uniform depth of about ⅛ and ⅜ inch apart, which leaves the surface in excellent condition for finishing with the flat chisel.

* * *

## WE WERE MISTAKEN.

Our attention has been called to an erroneous answer in the August issue of MACHINERY to Question 105, How and Why Department, by Mr. Porter Stafford, of Erie, Pa. The answer as given states that the crank of a bicycle should be constructed so that the pedal having the right-hand thread would screw into the left crank, and the one having the left-hand thread would go into the right crank. The reason for the answer was based on an examination of a bicycle which in the light of further investigation appears to have been wrongly constructed, and on the superficial theory that the backward tendency of the pedal would tend to continually tighten the pedal pins in the cranks when threaded as prescribed. The practice of the best makers, however, is exactly to the opposite, the right pedal having a right-hand thread and vice-versa. It is under these conditions only that the pedal pins tend to tighten in the cranks when under the influence of the rider. The reason for this apparently contradictory action is the slight epicylclic movement that takes place between the threads of the pedal pin and those of the crank, being caused by what is known as the "wabbling action." The epicyclic movement may be easily demonstrated by taking a bolt having a loosely threaded nut, which is secured in a vise. Now give the end of the bolt a rotating action without actually turning it, and if the bolt be loosely grasped by the fingers, it will turn slowly in a direction opposite to the motion of the hand. So if the bolt has a right-hand thread and the motion given be in the direction of the hands of a watch, the resultant motion will slowly unscrew it from the nut.

In the bicycle crank, the same action takes place even if the thread be a close fit, for the action of the rider's foot tends to give the pedal pin a wabbling action which, though very minute, still by reason of the epicyclic movement tends to turn it forward as regards the crank and the whole machine. If then, the left crank and pedal pin have left-hand threads, the pin will always tend to tighten in the crank, and consequently the right crank with its pin should have right-hand threads.

* * *

## NICKEL STEEL TUBES.

In connection with the article in this number upon the Bethlethem Steel Co., who make a specialty of heavy forgings of nickel steel, a paper read before the Institution of Naval Architects by A. F. Yarrow will prove of value. The paper reported experiments made to determine the relative durability of boiler tubes of mild steel and nickel steel, the mild steel tubes being such as have hitherto generally been used in water tube boilers and the nickel steel tubes containing from 20 to 25 per cent. of nickel. The paper is summarized in "The Engineering Magazine," from which we quote.

The causes of the deterioration of boiler tubes are given as (1) action of acids in the water, due to the presence of grease, (2) oxidation on the outside by the action of the furnace gases, and (3) deterioration on the inside by the action of superheated steam.

Mr. Yarrow endeavored to repeat as nearly as possible the conditions which exist in actual practice, and by exposing both kinds of tubes to the same influence, to determine the relative resisting power of each.

The corrosion test was made by suspending weighed pieces of each kind of tubing in dilute hydrochloric acid for periods varying from 21 to 168 hours, the extent of the corrosion being determined by the loss of weight in each case. This test showed a remarkable advantage in favor of the nickel steel, the loss by corrosion of the mild steel tube being 16½ times what it was in the nickel-steel tube. Mr. Yarrow remarks that it may be contended that the relative corrosion of the two specimens when using dilute hydrochloric acid does not correspond with what it would be with such acids as are present in boilers under working conditions, but says, that it is not unreasonable to suppose that it may serve as a guide.

The second test was intended to show the action of gases and fire upon the exterior of the tubes. In this experiment two tubes were placed in a small brick furnace arranged so that they would be heated under identically the same conditions. The extent of the corrosion by the action of the heat and gases was determined by the loss in weight after repeated heating and cooling, the scale being removed between each heating, and the tubes weighed to ascertain the rate of loss. After five such heatings, coolings, and scrapings the nickel steel tube was found to have lost about 27 per cent. of its weight, and the mild steel tube 76 per cent., thus showing that the nickel steel resisted fire corrosion 2.9 times better than the mild steel.

The test with superheated steam was also in favor of the nickel steel, tubes of this material lasting 2 1-3 times as long as when of mild steel.

* * *

Most emery-wheel companies advise running their wheels at about 5,500 feet a minute.

# FLY-WHEEL DESIGNING.

## PRACTICAL SUGGESTIONS FOR THE DESIGNER, WITH AN EXPLANATION OF THE NECESSARY CALCULATIONS.

C. H. BENJAMIN.

In writing on this subject I shall begin at the beginning and not assume that the reader knows all about fly-wheels. Any reader who finds he is going over old ground may just stop and rest until the procession catches up with him. The object of all fly-wheels is to equalize the energy exerted and the work done and thereby prevent great changes of speed.

By energy exerted I mean the energy or power at the beginning of the machine, as at the cylinder of the engine or the driving belt of the shear press. By work done I mean the work at the end of the machine, as the belt wheel of the engine or the jaws of the press. If at any time the energy given to the machine is greater than the work which it is doing, then will the machine go faster and faster. So if at any time the energy exerted is less than the work being done, the machine will continue to lose speed.

In a shear press or punch the energy of the driving belt remains practically constant, but the work done by the jaws varies from practically nothing at return stroke to the full power of the machine when cutting. In an engine, on the other hand, the work done by the belt wheel may be constant, or nearly so, while the energy exerted by the steam on the piston varies throughout each stroke. Furthermore, in any engine using a connecting rod and crank, the energy exerted on the crank pin, tending to turn the shaft, varies from nothing at the end of the stroke to its greatest value near mid-stroke. A steam engine without a fly-wheel would be useless and could not make one revolution.

Now in what way can a fly-wheel help to overcome this difficulty? If such a wheel of large diameter and with a heavy rim were mounted on ball bearings to reduce the friction, it would even then be found difficult to set it in motion or increase its speed suddenly, on account of its inertia. To give to it any particular increase of speed would require a certain amount of work or energy put into it. Having once acquired speed it would be capable of doing the same amount of work on any opposing body by virtue of this stored energy.

So the fly-wheel of the engine or press, as long as the energy exerted is greater than the work being done, will turn faster, the inertia of its rim absorbing excess of energy. On the other hand, if the energy becomes less than the work, the wheel turns slower and slower, giving up its stored energy to supply the deficiency. The heavier the rim, and the greater its velocity, the less the change of speed for a given storage of energy.

In the steam engine these changes of speed occur twice in every revolution, the wheel moving most slowly near one-quarter stroke and most rapidly near three-quarters stroke, the exact times being dependent on the point of cut-off and the connecting-rod ratio. The use of the fly-wheel is often confused with that of the governor. The fly-wheel can only average the speed during one revolution and prevent violent changes in that time. It has no control over the number of revolutions per minute.

On the other hand, no ordinary governor works quickly enough to regulate the speed in one revolution.

The governor prevents any permanent change in speed by adapting the amount of steam admitted to the amount of work to be done. A governor will prevent an engine from running away; a fly-wheel cannot.

### Weight of Rim.

In order to determine the weight of rim of a fly-wheel, it is necessary to know the probable excess and deficiency of energy in each stroke and the per cent, of variation in speed that can be tolerated. The earlier the cut-off of the engine the greater the variation in energy and the larger the fly-wheel that will be required. The weight of the reciprocating parts and the length of the connecting-rod also affect the variation.

In a subsequent article I will show how this may be determined graphically for any engine. At present it will suffice to assume it. The following table from Rankine's Steam Engine shows about what may be expected.

TABLE I. CONDENSING ENGINES.

| Fraction of stroke at which steam is cut off.............. | $\frac{1}{3}$ | $\frac{1}{4}$ | $\frac{1}{5}$ | $\frac{1}{6}$ | $\frac{1}{7}$ | $\frac{1}{8}$ |
|---|---|---|---|---|---|---|
| Per cent of energy............. | .163 | .173 | .178 | .184 | .189 | .191 |

NON-CONDENSING ENGINES.

| Steam cut off at........................... | $\frac{1}{2}$ | $\frac{1}{3}$ | $\frac{1}{4}$ | $\frac{1}{5}$ |
|---|---|---|---|---|
| Per cent. of energy........................ | .160 | .186 | .209 | .232 |

To obtain the excess of energy from this table it is only necessary to find the average work in foot-pounds done by the engine in one revolution and multiply this by the decimal given in the table. We will call this excess of energy E.

The allowable variation in speed depends upon the use to which the engine may be put. In modern engines an allowance of from 1 to 2 per cent. is usual.

The limits of this article prevent me from developing at length the common formula for weight of rim. Since an explanation of this formula may be found in nearly any work on the steam engine it is hardly necessary to reproduce it here.

I will give a convenient form and illustrate its use by an example:

Let W be weight of rim in pounds.
Let D be mean diameter of rim in feet.
Let N be number of revolutions per minute.
Let $\frac{1}{n}$ be allowable variation in speed (from 1-50 to 1-100).
Let E be excess and deficiency of energy in foot pounds.
Let c be factor from table.
Let HP be indicated horse-power.

Then if the indicated horse-power is given:

$$W = \frac{387587500 \times c\,n \times H\,P.}{D^2\,N^3} \quad \ldots\ldots\ldots\ldots (1)$$

If the work in foot pounds is given, then:

$$W = \frac{11745\,n\,E}{D^2\,N^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

E is calculated as before explained. From these formulas it will be seen that increasing the diameter or the speed of a wheel diminishes the necessary weight of rim very rapidly.

To make clear the use of these formulas, we will work two examples, such as might arise in practice.

Ex. 1. A non-condensing engine of 150 indicated horse-power makes 200 revolutions per minute, with a variation of 2 per cent.

The average cut-off is at one-quarter stroke and the fly-wheel is to have a mean diameter of 6 feet. Required the necessary weight of rim in pounds.

From the table we find c = .209. and from the data given we evidently have:

HP. = 150; N = 200; $\frac{1}{n}$ = 1-50 or n = 50; D = 6. Substituting these values in equation (I) we have:

$$W = \frac{387587500 \times .209 \times 50 \times 150}{36 \times 200 \times 200 \times 200}$$

or W = 2110 pounds nearly.

Ex. 2. A condensing engine, 24×42 inches, cuts off at one-third stroke and has a mean effective pressure of 50 pounds per square inch. The fly-wheel is to be 18 feet in mean diameter and make 75 revolutions per minute with a variation of 1 per cent.

Required weight of rim.

The work done on the piston in one revolution is, therefore: pressure on the piston multiplied by the distance traveled or twice the stroke in feet. The area of the piston in this case is 452.4 sq. ins., and twice the stroke is 7 feet.

The work done on the piston in one revolution is, therefore:

452.4×50×7 = 158,340 foot pounds.

From the table c = .163. and therefore:

E = 158,340 × .163 = 25,810 foot pounds.

From the data given we have: n= 100; D = 18; N = 75.

Substituting these values in equation (2):

$$W = \frac{11745 \times 100 \times 25810}{18 \times 18 \times 75 \times 75} = 16640 \text{ pounds nearly}$$

### Dimensions of Rim.

In the above formulas D, the mean diameter of rim, is really twice the co-called radius of gyration and would be found by squaring outer and inner diameters, adding them together, dividing by two and extracting the square root. In symbols this would read:

$$D = \sqrt{\frac{D_1^2 + D_2^2}{2}}$$

It is usually accurate enough to take $D = \frac{D_1 + D_2}{2}$, or the arithmetical mean

To illustrate we will assume $D_1 = 8$, $D_2 = 9$, then:

$$D = \sqrt{\frac{64 + 81}{2}} = 8.514$$

But the mean of 8 and 9 is 8.5, which is accurate enough in practice.

The number of cubic feet in the rim may be found by dividing the weight in pounds by 450 for cast iron or 480 for steel.

For instance, the rim in Ex. 1 would contain:

$$\frac{2110}{450} = 4.69 \text{ cu. ft. of cast iron,}$$

and the one in Ex. 2 would contain: $\frac{16640}{450} = 36.98$ cu. ft.

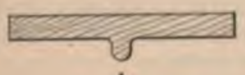
The area of cross section of rim may be found approximately by dividing the cubic contents by the circumference corresponding to the mean in diameter D. This area in Ex. 1 would be:

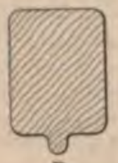
$$\frac{4.69}{6 \times 3.1416} = .2487 \text{ sq. ft.} = 35.83 \text{ sq. ins.}$$

and in Example 2:

$$\frac{36.98}{18 \times 3.1416} = .654 \text{ sq. ft.} = 94.2 \text{ sq. ins.}$$

The shape of the cross-section is determined by the use to be made of the wheel. If it is a belt wheel the width of rim is determined by the width of belt, and the section is usually something like A, below. If the wheel is to be simply a fly-wheel, it is better to adopt a stronger form of section and one easier to fasten at the joints. A common form in such cases is like B. In very large wheels it is better to make the rim and arm hollow, as it is easier to cast and easier to put together. To illustrate the above principles, we will assume that the wheel in Ex. 1 is to carry a double leather belt sufficiently wide to transmit the desired horse-power. As this is not a paper on belting, I will only say that under the given conditions a belt 18 inches wide would be sufficient.


A


B

We may then assume that the rim should be a little wider than this, or say 19 inches.

The thickness will then be:

$$t = \frac{35.83}{19} = 1.88⅞ \text{ inches nearly.}$$

On the other hand, if we assume the wheel in Ex. 2 to be used solely as a fly-wheel, we can take any proportions which may be convenient. If a width of eight inches is chosen, the depth will be:

$$\frac{94.2}{8} = 11¾ \text{ inches nearly.}$$

and the wheel will be about 19 feet in outside diameter.

If it is decided to make the rim hollow and a thickness of two inches is adopted, the proportions would be about as in Fig. 1.

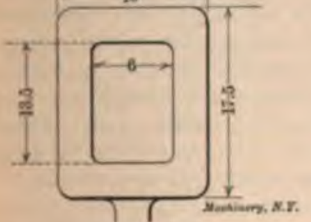


Fig. 1

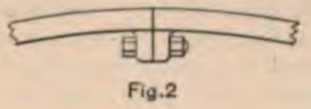


Fig. 2

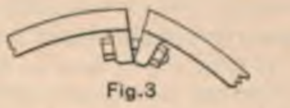


Fig. 3

### Joints in Rims.

Wheels less than 8 feet in diameter are usually cast solid. Wheels from 8 to 16 feet in diameter may be cast in halves to facilitate transportation. Wheels larger than 16 feet are usually cast in several pieces, the hub being a separate piece. Each arm may have a segment of the rim cast with it, but in the larger sizes of wheels the segments of the rim are bolted to the arms as well as to each other.

The bolts must be kept as snug to the rim and as far from the lower edge of flange as possible.

Until quite recently it has been customary to join the segments of the rims of belt pulleys by internal flanges and bolts, the joint coming midway between the arms. Theory and experiment both show this to be a very unsafe arrangement,* the strength of the joint being only from one-fifth to one-third that of the solid rim. When the wheel is running at a high speed, the pressure of the centrifugal force bends the joint out and opens it as shown in Fig. 3, thus throwing a great additional stress upon both bolts and flanges. If a joint like the above is adopted, it should be strengthened by wrought iron or steel tension rods, running from the flanges to the hub, and preventing the rim from bending at the weak point. (See Fig. 4.) Mr. James Stanwood has suggested placing such a joint at a point one-quarter way from the arm, where the bending is practically nothing.

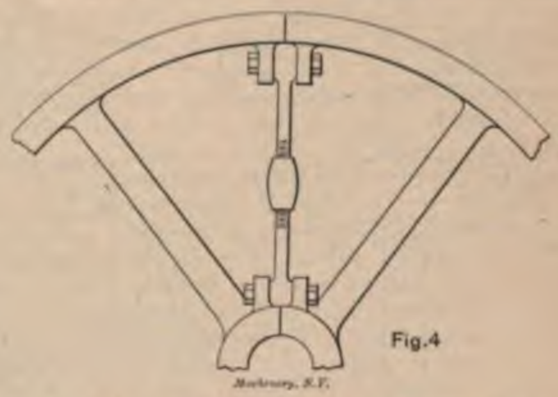


Fig. 4

Most engine builders of late have put the joints in the rim directly over the arm. In any case, the bolts should be located as close to the rim as practicable.

Fig. 5 shows a joint in a belt wheel rim as made by a well-known firm of engine builders. This is a wheel 24 feet in diameter, with a 64 inch face intended for two belts. The flanges are well braced by the internal ribs and the bolts which hold the arms also assist in strengthening the rim joint.

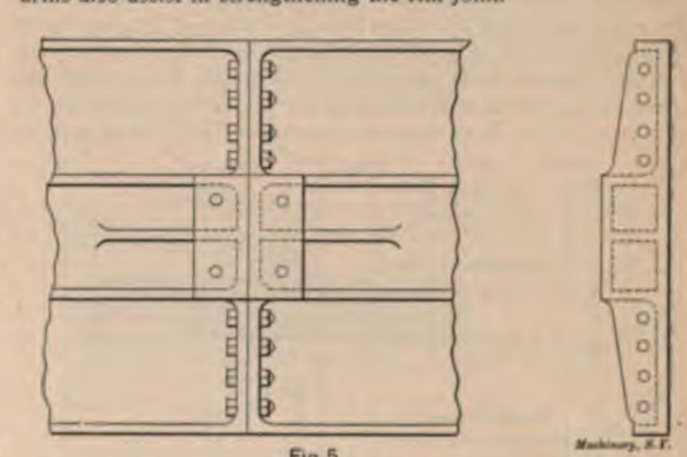


Fig. 5

If a rim of this kind is very wide the centrifugal force tends to stretch the outer edges of the rim and to crack the cross flanges near the arms. In such cases it were better to use two sets of arms or two separate wheels.

A much safer and better rim, where it can be used, is the narrow and deep form. The tendency of bending between the arms due to centrifugal force is then resisted by the great depth of metal.

The links or bolts which form the joint can be placed nearer the center of the rim, where the bending will not affect them.

Two common forms of joints are shown in Figs. 6 and 7.

The links or prisoners, as they are sometimes called, are let in on the two opposite sides of the rim and occasionally on the inside face as well. They are usually put in hot and allowed to shrink into place, drawing the joint firmly together.

Experiments made at the Case School have shown that a joint of this kind may have a strength two-thirds that of the solid rim.

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* See "Bursting of Small Cast Iron Fly-wheels," Trans. A. S. M. E., Vol. XX., p. 109.

If the section of the rim is slightly increased where the link is inserted, the strength will be greater. (See Fig. 7.)

In a paper read before the American Society of Mechanical Engineers,* Mr. John Fritz has called particular attention to the advantages of the hollow rim and arms in fly-wheel construction. Fig. 8 is a sketch of a joint in such a wheel. The coring of the rim insures a sounder casting and also makes it possible to get a stronger joint, by thickening the metal at that point. The links are made of different lengths so that the heads will not all come at the same point.

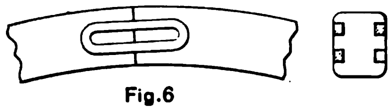

Fig.6

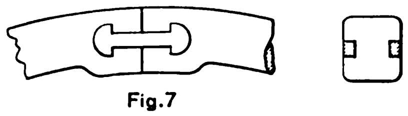

Fig.7

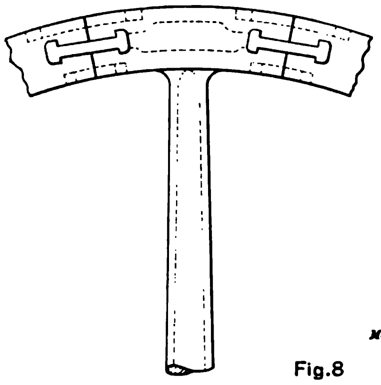

Fig.8

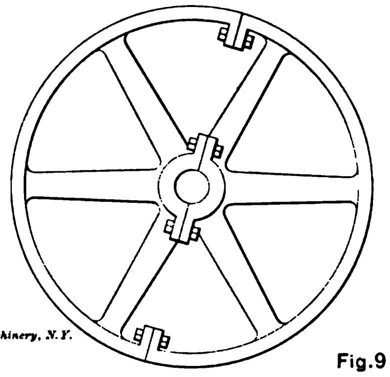

Fig.9

### Size of Arms.

It is not possible to give any definite rule for determining the breadth and thickness of fly-wheel arms, there are so many disturbing factors. The thickness of the metal should be as uniform as possible, and where the arm joins the rim, if cast on, the change of thickness should be gradual, to avoid cooling strains.

Increasing the number of arms will strengthen the rim by diminishing the bending between the arms.

Under ordinary circumstances the stresses on the arm of a fly-wheel are slight, but when started or stopped suddenly, as in rolling-mill work, it is hard to calculate how large they may be.

†Experiments made on ordinary belt pulleys have shown that the bending due to belt tension is not evenly distributed among the arms, but is about twice as great on the arm which happens to be next the tight side of the belt at any instant. This difference is probably less in fly-wheels, on account of their stiffer rims, but even here I should prefer to design the arms for about twice the average moment.

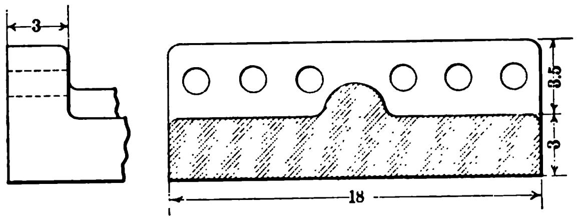

Fig.10

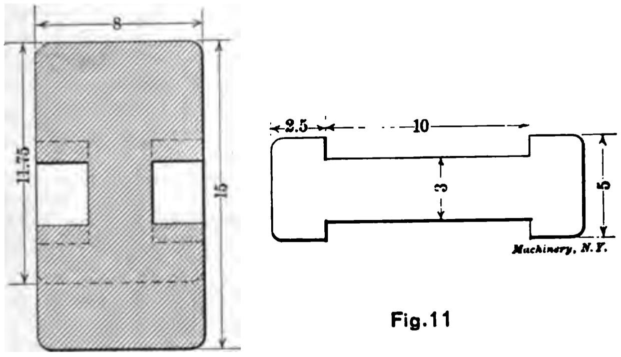

Fig.11

### Examples.

Ex. 3. It is required to design an internal flange joint for a fly-wheel rim 3 inches thick and 18 inches wide, the wheel being 10 feet in diameter and built in two halves.

A simple design in such a case is to part the wheel on a diameter which shall pass near two of the arms, as in Fig. 9. The distance from the joint to the center of the arm should not be more than one-quarter the space between the arms.

The flanges should be of approximately the same thickness as the rim. We will use steel bolts having a tensile strength of 75,000 pounds per square inch. If the metal in the rim has a tensile strength of 18,000 pounds per square inch the total tensile strength of the rim is $3 \times 18 \times 18{,}000 = 972{,}000$ pounds.

It will be found difficult to make the strength of joint more than one-third this, or 324,000 pounds.

$$\frac{324000}{75000} = 4.325 \text{ sq. ins. of bolt area required.}$$

Six 1¼ inch bolts will have a combined area at the root of thread; $6 \times .89 = 5.34$ square inches.

With bolts even as large as this, the flange will probably break before the bolts. The joints would appear as in Fig. 10.

The bolts must be kept as snug to the rim and as far from the lower edge of flange as possible.

Ex. 4. Let it be required to design a link joint for the rim of the wheel in Ex. 2, supposing the rim to be solid, 8 inches wide and 11.75 inches deep.

Assuming the tensile strength of the cast iron as 18,000 pounds per square inch, the total strength of rim is:

$8 \times 11.75 \times 18{,}000 = 1{,}692{,}000$ pounds.

If the tensile strength of the steel used for links is taken as 75,000 pounds per square inch, and we try to make the joint two-thirds as strong as the rim, we shall need:

$$\frac{2}{3} \times \frac{1692000}{75000} = 15 \text{ sq. ins. of steel.}$$

If we adopt the form of joint shown in Fig. 7 and use two links, the area of cross-section of each link will be 7.5 square inches, or $2.5 \times 3$ inches. Fig. 11 shows the proportions of such a joint. As the heads of the links will remove $2 \times 2.5 \times 5$, or 25 square inches of metal from the cross-section of the rim, it will be necessary to add this amount by increasing the depth at the joint to about 15 inches.

* * *

In referring to the radiation from steam pipes in an article in a recent number of "The Engineering Magazine," R. S. Hale states that he believes too large pipes are used in a great majority of steam plants. While this opinion may appear heretical, it does not seem unreasonable with Mr. Hale's explanation added. He says, "the steam pipes close to the engine must be large, otherwise the pressure will fall during admission to the cylinder; but if a large steam pipe or steam reservoir be provided close to the engine, of sufficient size to keep up the prssure during the admission period, then (for an engine cutting off at one-quarter stroke) the steam pipe from the boiler to this reservoir need be of only one-quarter of the area or one-half the diameter usually used. The writer has often seen a 12-inch main with 6-inch offset pipes, leading to the engines, and wondered whether a 6-inch main with 12-inch offsets to the engines would not give a higher initial pressure on the indicator card."

* * *

An item in "Electricity" says that of late all sorts of impossible names have been suggested for a self-propelled vehicle in lieu of the word "automobile." A recent writer to a daily paper urges, apparently without any special reason, that the name "tomole" be adopted. The next thing will be that some one with a vivid imagination will suggest that an electrically propelled vehicle be called a "tamale" and a mineral spirit motor-driven carriage a "hot tamale," which latter designation—especially the first part of it—would seem very appropriate and almost as sensible as the name suggested by the correspondent referred to.

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* Transactions A. S. M. E., Vol. XX.

† American Machinist, Sept. 22, 1898.

# A SYSTEM OF PATTERN KEEPING.

G. H. HALL.

The advantage of having a complete record and a convenient arrangement of patterns is unquestionable, but the extent to which this recording and arranging may be carried must depend upon the circumstances governing the particular case. In the large works a pattern keeper and inspector is employed and the recording is systematized to a very fine point. In the smaller shops, however, when the amount of work is not sufficient to warrant a regular keeper, the patterns are usually picked out by a draftsman or superintendent and sent into the foundry, and when the work is completed are returned to the most convenient shelf by one of the moulders.

The next time this pattern is wanted, lucky is the draftsman if he finds it at all, and more so if some of the core boxes have not been misplaced or lost.

NAME OF MACHINE. 20' Lathe

PATTERN MARK. 20L

| NAME OF PIECE | PATTERN NUMBER | NO. PER MACH. | MATERIAL | PATTERN MADE OF | NO. OF LOOSE PCS. | NO. OF CORE BXS. | NO. OF STOCK CORES | WEIGHT OF CASTING | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| Bed | 1 | 1 | CI | Wood | 2 | 1 | 4 | 780 | |
| Leg (Tail End) | 2 | 1 | CI | Wood | 0 | 0 | 2 | 200 | |
| Leg (Head End) | 3 | 1 | CI | Wood | 3 | 0 | 2 | 220 | $\underset{2}{20L}$ altered |
| Head Stock | 4 | 1 | CI | Wood | 6 | 3 | 0 | 340 | |
| " " Cap | 5 | 2 | CI | CI | 0 | 0 | 0 | 58 | |
| Spindle Box (Front) | 6 | 1 | Bz | CI | 0 | 1 | 0 | 20 | |
| " " (Back | 7 | 1 | Bz | CI | 0. | 1 | 0 | 22 | |
| Core | 8 | 1 | CI | Wood | 2 | 1 | 1 | 85 | |
| | | | | | | | | | |
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PATTERN SHEET.

The system of pattern keeping here described is applicable to such shops as this where the handling of the patterns may fall to anyone of several persons, the idea being to have the record so placed as to be convenient for any one to refer to, and the place for each pattern so marked as to offer no excuse for anyone to misplace it.

The record is the first part of the problem to be dealt with, and while some alterations may be necessary for different classes of work, we will consider the case of a shop manufacturing several sizes of lathes, shapers, drill presses, etc.

First, a letter is selected to represent each of the different tools. The first letter of the tool name is preferable unless two tools have the same initial letter when another letter may be chosen for one of them. Thus L would represent lathes; S, shapers; D, drill presses, etc.

Prefixed to this is the number indicating the size by which the machine, to which the pattern belongs is known, as 10 L for a pattern belonging to a lathe of 10 inch swing; 24 S for one belonging to a 24-inch stroke shaper. This combination of number and letter forms what is known as the pattern mark. Under this mark the patterns are arranged in serial, so far as possible, giving the same number to similar parts; that is, lathe beds would be, $\underset{1}{10L}$, $\underset{1}{18L}$, $\underset{1}{24L}$; headstocks, $\underset{4}{10L}$, $\underset{4}{18L}$, $\underset{4}{24L}$, etc. This, however, is applicable only to the principal parts, as it seldom happens that the different sizes are composed of exactly the same parts. The record is now made out as shown in the above sample, which is a copy of a pattern sheet for a 20-inch lathe.

These sheets should be printed in blank on bond or parchment paper from which prints can be made, and should be of the same size as a standard drawing sheet, so as to facilitate filing. The ones in use by the writer are 9 inch by 12 inch, which is the size of a standard one-eighth size drawing. This record is made out and kept in the drawing room and when the drawing of a piece is made, it is entered on the record by name, number, material, and number per machine. The number assigned to the pattern is put on the drawing and, by the pattern maker, is stamped on the finished pattern. When the pattern is completed, it should be examined by the draftsman and the record completed by filling in the number of loose pieces, core boxes, stock, cores, and any remarks which he may think neccessary. The column containing the weights of the castings will be found very useful in estimating or to use for reference in taking inventory of stock. The record on bond paper may be used by the office and drawing room in ordering castings, but it should never be allowed to go into the shop. For shop use blue prints are made and mounted on small boards as shown in Fig. 1. These are a little larger than the sheet and are provided at the top with a drilled hole by which they may be hung up. The name of the machine indexed is painted in black on a white strip at the top of the board, or a strip of paper bearing the name of the machine may be pasted on the board. The blue prints are stuck on these boards just below the title and the boards are hung upon the shelves where their respective patterns are placed. When only one or two additions are made to the original pattern list the changes can be made on the blue prints with yellow crayon; but blue prints are cheap and as soon as a number of changes are made, the old print should be removed and a new one put on.

But little can be said regarding the shelves on which the patterns are kept, as the space devoted to pattern storage is so varied, but when new shelves are erected, the arrangement shown in Fig. 2 will be found very convenient. Each machine is given a separate tier of shelves and the patterns are arranged as shown in the figure; the heavier ones occupying the floor space. The smaller ones are placed on the lower and more convenient shelves, while the higher and less available space furnishes a desirable place for keeping master patterns and patterns of jigs, fixtures, etc., which, although seldom used, are too valuable to be lost or misplaced. If the number of such patterns is very great they also should be indexed in a manner similar to the regular patterns.

The index board is hung in a conspicuous place as shown in the figure, and when a pattern is desired its place can immediately be found by these boards. The index shows just what kind of a pattern one is to look for, the number of core boxes and loose pieces and the number of stock cores to order.

The weight of the casting shows whether the pattern is large or small so that one knows at once whether to look on the floor or on the shelves for the pattern desired.

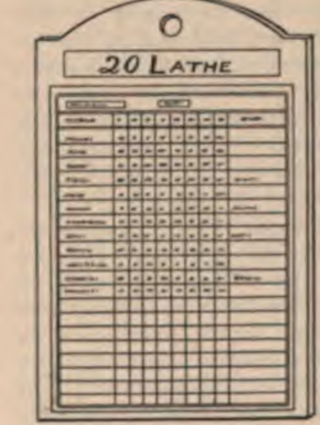


FIG. 1.

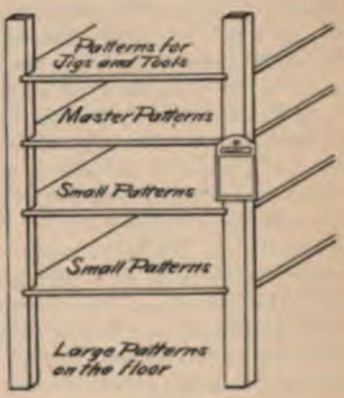


FIG. 2.

In returning the pattern, the index should again be consulted to make sure that all the loose pieces and core boxes are returned with the pattern.

The foregoing shows just how one set of patterns is being kept in a very satisfactory manner and by slight alterations that the different classes of work may require, it will be found a very convenient method of keeping any kind of patterns with but little trouble or attention.

* * *

Where are the largest machine tools located in this country? What are their dimensions and by whom were they made? These are questions that subscribers sometimes ask us, and that all mechanics would like to have answered. We will gladly welcome any information that readers are able to give us regarding tools of unusual proportions.

## LIFE AND METHODS IN A GERMAN SHOP.

ROBERT GRIMSHAW.

At the principal repair-shops of the Royal Saxon Government Railways at Chemnitz, Saxony, there are at present employed over 1,500 men. One of the first things which strikes the visitor on entering the establishment is the restaurant. It may be laid down as a broad general principle that no German is going to be more than one-quarter mile from a restaurant, nor more than one-eighth mile from a Bier-Stube. The restaurant is a governmental affair, with plain tables and benches for 600 men at once, and has at one end large heating tables with sand-baths, on which the workmen who come from too great a distance to permit of going home for dinner (the shops are at the edge of town) can heat their coffee, etc., free of charge. Those who do not bring their eatables and drinkables with them can buy them of the government at a fixed published rate; sausages, sandwiches, etc., as well as coffee and beer, being obtainable.

For the accommodation of those workmen who live at too great a distance from the shops to permit of walking, the government runs special workmen's trains (on which the workmen ride free) at suitable times to bring them to the shops and take them away without making them too late or too early.

In the lower half of each window of the restaurant hall (which is also the pay-room) there is fitted a large board with several hundred numbered hooks, from which the workmen as they go through, take off, or on which they hang up their brass time-checks; the board being turned so as to face outwards at coming time and in the room at going time.

Accident and life insurance are compulsory. In each shop-building there is an "emergency closet," in charge of the employee at the nearest machine, and this contains all necessary bandages, plasters, ointments, and simple implements for treating cuts, burns, scalds, and bruises, and for removing bits of steel from the eye, as well as cholera-drops and a few other remedies likely to prove useful.

The heating devices are steam pipes under the work-benches which line the walls. The system of overhead steam-pipes which we find in some American shops, especially where there is a great number of vertical belts to establish a circulation of the heated air, is unknown in this country, and elicited very uncomplimentary remarks as to its practicability.

In paying off, each man receives his cash at the end of the week, in a tin "capsule," like a blacking-box, bearing his number: and this is enclosed in an envelope bearing or containing a detached statement of the amount paid, and the time or jobs for which it is paid. The workman verifies the amount and the details, and if there is any error or discrepancy, or he has any reason to be dissatisfied, he makes his complaint at once. On going out, he deposits his metal capsule (which, of course, has the same number as his time-check) in a general receptacle, from which it is taken to be used at the next pay-day.

These shops make their own leaf springs (spiral springs under cars are nearly unknown here). The spring-heating ovens are side-fired; the heating chamber being double-ended, and the firing chamber also, each having counterbalanced doors at each end. The flames pass over the springs, which lie on a flat iron hearth-plate, and then having thus traversed the oven crosswise, pass back again crosswise directly under the spring-hearth; next passing crosswise again in the first direction, at the bottom of the oven, and out to the flues which lead to the stack. There are square holes at each end of the ovens, closed with cast-iron plates, to permit of cleaning out these flues.

All tires are fastened on to the centers with dove-tail rings, having an opening into which is driven a key. This method of fastening has the disadvantage that at times the tires slip around a bit on the centers. It must be remembered that cast-iron centers for either locomotive or car wheels are here unknown; and many of the officials make me repeat my statement that "gusseisen" (cast-iron) can be trusted and is the rule with us, for this purpose. They think that I get the name wrong for "flusseisen" (ingot-iron).

There is a great deal more anvil forging done here than with us; for instance, the buffer-guides are forged up as three- armed or four-armed spiders having a central hole, and then upset so as to make tripod-like guides, which are bolted to the buffer-beam and through which the stems of the buffers (two for each car) pass. Then there are the chains and hooks by which the cars are coupled, and numerous other parts which are either totally lacking on our cars, or are made with us of gray iron or malleable; or if of wrought-iron are drop-forged or hydraulic-squeezed.

I found that the shops were now making the 1½ inch crucible-steel anti-friction balls for turn-tables, by hand forging, at a cost of 00 pfennings (less than 15 cents), all finished smooth, as against 3 marks (about 71 cents), which they used to cost when turned up in the lathe.

On every engine tire there is a "limit line" turned:—a score which indicates the minimum thickness permissible. This seems to me in some respects better than a mileage limit. Tires are run to a certain thickness under fast express passenger trains and then degraded to "personen-zug," or ordinary passenger service, before being put into the freight traffic. (These "personen zuge" are usually called by the traveling public "bummelzuge," or bummer trains; and the fare is always less on them than by the fast trains; or rather all tickets are good for the common trains, and if you travel by express train you must buy an "erganzungs billet," or "zuschlag billet" at about one-eighth extra.)

Here copper fire-boxes are used exclusively, and the stay-bolts are of copper, 1 inch thick in the cylindrical part, and 1¼ inch over the threads; being screwed in and then riveted over. Each bolt is drilled centrally nearly half way through from each end. On some other roads the drill-hole is nearly through from the inner end, and on some nearly through from the outer.

* * *

## ENGINE EFFICIENCY.

To arrive at an idea as to the limits between which improvement in the present steam engine may be expected, let us take the case of an engine, such as that of a locomotive, working non-condensing and using, say, 3.5 pounds of coal per hp-hour. In the case of a locomotive, 50 per cent. would probably be a high efficiency for the boiler, thus allowing but 1¾ pounds of coal to be utilized in making steam. Assuming that the combustible matter in a pound of coal will give rise to 13,000 heat units, we will have 22,750 heat units from the given consumption of coal per hp-hour. Assuming a boiler pressure of 150 pounds and a back pressure of 4 pounds, the temperature range of working is 141 degrees; the absolute temperature of steam at 150 pounds pressure is 829 degrees, and since the ratio between these figures gives the heat available for transformation into work, in this case 17 per cent. of the heat units supplied to the steam or 3,867 heat units, are thus available. As a hp-hour contains 2,545 heat units, this gives with the above data for the given steam engine, considering it as a machine for turning heat into work within the limits set by the second law of thermodynamics, an efficiency of 65 per cent. Owing to the nature of heat losses, it cannot be expected that this efficiency may be very largely increased. Of course, by using higher pressures and the condenser, a greater economy may be obtained with the same type of steam engine, but little greater efficiency, as 70 per cent. is about the upper limit for the most improved modern types of engines. Yet 70 or even 65 per cent. scarcely justifies the opinion very widely held as to the inefficiency of the steam engine, and certainly bars claims for double or triple increase of efficiency, which claims do not seem impossible when the figures for thermal efficiency are considered as those upon which improvement is to be made.—ELECTRICAL WORLD.

* * *

It is said that to the province of Quebec belongs the credit of having built the first steamship that crossed the Atlantic from either side. The steamship was called the "Royal William," commanded by Captain McDougall, and sailed from Quebec on the 5th of August, 1833, arriving at Gravesend on September 11, having steamed the whole distance. This seems at first sight to contradict the well-known claims to priority made for the "Savannah" as the first steamship to cross the Atlantic. The "Savannah," however, on her memorable voyage from Savannah to Liverpool (May 26, 1819, to June 20, 1819) used her engines during 18 days and progressed under sail the remainder of the time, the paddlewheels being hoisted on board when not in use.

## WHO INVENTED STEAM NAVIGATION?

### POSSIBLY THE HONOR BELONGS TO A SPANIARD OF THE SIXTEENTH CENTURY, INSTEAD OF FULTON AN INTERESTING PRESENTATION OF THE EVIDENCE.

One of the most interesting and scholarly books ever written is that by Thomas Ewbank upon hydraulics and mechanics. The first edition appeared in 1841 and it has since run through at least fifteen editions. We presume the book is now out of print, but copies are to be found in many of the large libraries.

The book is largely historical and treats exhaustively upon various branches of the development of mechanics. In discussing steam navigation it states that in 1543 a naval officer is said to have propelled a ship of two hundred tons by steam in the harbor of Barcelona. No account of the machinery exists except that there was a large copper boiler and that there were paddle-wheels at the sides of the vessel. Like all old inventors this officer refused to explain his mechanism. The following account of the affair is said by Ewbank to be a copy of the official records contained in the Spanish Royal Archives:

#### From the Official Records.

"Blasco de Garay, a captain in the navy, proposed in 1543, to the Emperor and King, Charles the Fifth, a machine to propel large boats and ships, even in calm weather, without oars or sails. In spite of the impediments and opposition which this project met with, the emperor ordered a trial to be made of it in the port of Barcelona, which, in fact, took place on the 17th of the month of June, of the said year 1543. Garay would not explain the particulars of his discovery; it was evident, however, during the experiment, that it consisted in a large copper of boiling water, and in moving wheels attached to either side of the ship. The experiment was tried on a ship of 200 tons called the Trinity, which came from Colibre to discharge a cargo of corn at Barcelona, of which Peter de Scarza was captain. By order of Charles V., Don Henry de Toledo, the governor, Don Pedro de Cordova, the treasurer Ravago, and the vice-chancellor, and intendant of Catalonia, witnessed the experiment. In the report to the emperor and to the prince, this ingenious invention was generally approved, particularly on account of the promptness and facility with which the ship was made to go about. The treasurer Ravago, an enemy to the project, said that the vessel could be propelled two leagues in three hours—that the machine was complicated and expensive, and that there would be an exposure to danger in case the boiler should burst. The other commissioners affirmed that the vessel tacked with the same rapidity as a galley manoeuvred in the ordinary way, and went at least a league an hour. As soon as the experiment was made Garay took the whole machine with which he had furnished the vessel, leaving only the wooden part in the arsenal at Barcelona, and keeping all the rest for himself. In spite of Ravago's opposition, the invention was approved, and if the expedition in which Charles the Fifth was then engaged had not prevented, he would no doubt have encouraged it. Nevertheless, the emperor promoted the inventor one grade, made him a present of two hundred thousand maravedis, and ordered the expense to be paid out of the treasury, and granted him besides many other favors.

"This account is derived from the documents and original registers kept in the Royal Archives of Simuncas, among the commercial papers of Catalonia, and from those of the military and naval departments for the said year, 1543.

"Simuncas, August 27, 1825. "Thomas Gonzales."

#### Comments on the Above.

Ewbank says that so long as the authenticity of this document be admitted it is difficult to perceive how other than Blasco de Garay can be accredited with the invention of steam navigation. It may appear singular that this specimen of mechanical ingenuity should have matured in Spain, but at that time this country was probably the most promising scene for the display of such operations. Every one knows that half a century before Columbus could find a patron nowhere else.

Objections have been raised to the claim for Garay and we give them as Ewbank presents them, together with his discussion regarding them. They make interesting reading and we leave the reader to judge as to their value.

"The objections are: 1st. Because the document was not printed in 1543; 2d. It does not sufficiently prove that steam was the motive agent; 3d. If Captain Garay really did employ a steam engine, it was according to all appearance the reacting eolipile of Hero, and therefore nothing new.

"To us there does not appear much force in these reasons. M. Arago observes: 'Manuscript documents cannot have any value with the public, because, generally, it has no means whatever of verifying the date assigned to them.' To a limited extent this may be admitted. Respecting private manuscript it may be true; but surely official and national records like those referred to by the Spanish secretary should be excepted. So far from rejecting such sources of information respecting the arts of former times, we should have supposed they were unexceptionable.

"But it is said, although a boiler is mentioned, that is not sufficient proof that steam was the impelling agent, since there are various machines in which fire is used under a boiler, without that fluid having anything to do with the operations. Well, but the account states that which really appears conclusive on this point, viz., that this vessel contained 'boiling water,' and that Ravago, the treasurer, opposed the scheme on the ground that there would be an exposure to danger 'in case the boiler should burst.' As this danger could not arise from the liquid contents merely, but from the accumulation of steam (the irresistible force of which was, as has been observed, well known from the employment of the eolipiles), it is obvious enough that this fluid performed an essential part in the operation—in other words, was the source of the motive power. Had it not been necessary, Garay would never have furnished in it such a plausible pretext for opposition to his project. It has also been said that if Garay used steam at all, his engine was probably the whirling eolipile. There are, however, strong objections to such an opinion. That engine, acting on the same principle of recoil as Hero's eolipile, might have been made to propel a vessel of 200 tons is admitted; but for modern experiments with small engines of this description, we know: first, that in order to produce the reported result, the elasticity of the steam employed must have been equivalent to a pressure of several atmospheres; and second, that the enormous consumption of the fluid when used in one of these engines must have required either a number of boilers or one of extraordinary dimensions. Had Garay employed several boilers, the principal difficulty would be removed, as he might then have made them sufficiently strong to resist the pressure of the confined vapor; he, however, used but one, and every person who has witnessed the operation of reacting engines will admit that a single boiler could hardly have been made to furnish the quantity of steam required at the requisite degree of tension.

"As the nature of this Spanish engine is not mentioned, every person is left to form his own opinion of it. We see no difficulty in admitting that he employed the elastic force of steam to push a piston to and fro—or that he formed a vacuum under one by condensing the vapor. Such applications of steam were as likely to occur to a person deeply engaged in devising modes of employing it, in the sixteenth as well as in the seventeenth century, notwithstanding the objection so often reiterated that the arts were not sufficiently matured for the fabrication of a metallic cylinder and piston, and apparatus for transmitting the movements of a piston to revolving mechanism. The casting and boring of pieces of ordnance show that the construction of a steam cylinder was not beyond the arts of the sixteenth century, or even of the two preceding ones; while the water works, consisting of forcing pumps worked by wheels, and also numerous other machines put in motion by cranks (and the irregularity of their movements being also regulated by fly-wheels), show that engineers at that time understood the means of converting rotary into rectilinear motions, and rectilinear into rotary ones.

"It need not excite surprise that Garay adopted paddle wheels as propellers, since they were well known before his time, being of very ancient date. Roman galleys were occasionally moved by them, and they had probably never been wholly laid aside in Europe since the fall of the empire."

* * *

Only a few years ago, for electrical resistance, electricians used German silver wire, or some other form of metal resistance. Now, where a high resistance is required, a graphite resistance rod is used. A small rod of only a fraction of an inch in diameter and a few inches long has a resistance of thousands of feet of copper wire or German silver wire.

## HOW AND WHY.

### A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

**Give all details and name and address. The latter are for our own convenience and will not be published.**

6.—Subscriber desires to build a small engine of about one-half horse-power and desires a detailed sketch and description which will enable him to go ahead without any trouble.

A.—We recommend a book which has been recently published by the D. Van Nostrand Company called "Small Engines and Boilers," written by E. P. Watson, which will give him much valuable information together with hints and best methods for making the parts.

7.—W. C. A. desires to know: 1. A method for casehardening. 2. A method for annealing cast-steel. 3. A welding compound for tool and crucible steel.

A.—The best casehardening process is quite expensive and also requires considerable time for its action. The articles are packed in an iron box with bone dust, animal charcoal or leather scraps and subjected to a high temperature for about twenty-four hours, the box being sealed so that the atmosphere is excluded.

The receptacle is then opened and the articles, while red hot, are plunged into a bath of salt water, which hardens the outside to a depth of nearly one-sixteenth of an inch. The presence of the materials mentioned, together with the high temperature, changes the iron or low carbon steel to high carbon steel to a depth that depends (within limits) on the length of the time employed. This process is extensively used by some of the best bicycle builders for hardening the cups and cones, as low carbon steel can be used and the resulting product has a harder surface than would be permissible with those made of tool steel, together with a soft center which is not as likely to fracture. A cheaper and less effective process that is much used, however, consists of the use of cyanide of potassium, which is rubbed over the piece after being heated in an ordinary forge to a high red temperature. After the article has been well coated with the cyanide, it is reheated and then plunged in cold water. The casehardening resulting by this process is very superficial and does not compare with the first process in results. More effective results may be obtained by the use of cyanide of potassium by dipping the articles into a bath of the chemical, which is kept melted, and leaving the piece for a few moments until the surface is thoroughly saturated. After being reheated, the article is dipped until cold. Precaution must be taken when using the cyanide, as the fumes are very poisonous. 2. While there are numerous schemes used for annealing tool steel, probably the best method is the simplest, which simply consists in heating the steel to a full red and then burying it in ashes or air slacked lime, so that it will cool very slowly. The heating should be done uniformly and as quickly as possible, without subjecting any part to an excessive temperature. To anneal the self-hardening steels, it is necessary to heat them in a muffle and allow them to cool without being exposed to the air. 3. There are many welding compounds on the market which give excellent results, but none of them will work miracles. The higher the percentage of carbon the greater the difficulty in welding, so the best grades of tool steel are practically unweldable. A good flux that is generally available, is clean dry sand, and it will usually give results equal to any of the so-called welding compounds.

8.—W. H. B. desires to know if the following calculation is correct for the gear of a lathe to cut the fractional thread 3¼ to the inch, the conditions being the same as those given in W. H. Van Dervoort's article in the September issue with the exception that the lead screw has six threads per inch.

$$\frac{\text{Teeth in stud gear}}{\text{Teeth in screw gear}} = \frac{1}{2} \times \frac{6}{13} = \frac{6}{26} = \frac{3 \times 2}{13 \times 2} \text{ or}$$

20 and 20 tooth gears for one pair and 30 and 130 teeth for the other pair.

A.—The expression is incorrect, since the fraction $\frac{6}{3\frac{1}{4}} = \frac{24}{13}$ instead of $\frac{6}{13}$ as given by W. H. B. We then have

$$\frac{\text{Teeth in stud gear}}{\text{Teeth in screw gear}} = \frac{1}{2} \times \frac{24}{13} = \frac{24}{26} \text{ or } \frac{2 \times 12}{2 \times 13}$$

With this proportion, 20 and 20 tooth gears as one pair and 48 and 52 as the other pair, will enable the 3¼ thread to be cut.

9.—B wants to know the composition of a metal that will melt at 240 degrees temperature. He wishes to put a fusible plug on the steam side of his boiler, and as we understand it, not over the fire but in the steam space.

A. In Kent's pocket-book the following is given for a composition that will melt at 240 degrees: Lead 1, tin 4, bismuth 5. We should advise against placing dependence in a plug of this character.

* * *

## FRESH FROM THE PRESS.

SMALL ENGINES AND BOILERS, by Egbert P. Watson, a manual of instruction for the building of small engines. Over one hundred pages, with thirty full page working drawings. Published by the D. Van Nostrand Company, New York. Price, $1.25.

Many persons have at some period had a desire to build "something," and a prime mover usually proves to be the most attractive subject. For an amateur to attempt the construction of a small engine without any drawings or patterns is to invite disappointment and failure, but if the job is begun in a logical manner, there is no reason why a person with tools and a little mechanical ingenuity cannot construct an engine which will not only run but do work. The book under consideration begins with some excellent advice and gives many hints that will be found of value to the amateur, but no one should get the idea that they will be enabled by it to build an engine from old junk and without tools, for the author has set a standard of construction that only can be attained by the use of a good lathe and the necessary attachments.

While some of the designs given can scarcely be commended, we believe that they have been used in the construction of working models, and therefore the dimensions will be found reliable.

A new and handsomely illustrated magazine called "Feilden's Magazine" has appeared at London, Eng., which is intended to cover, in a comprehensive way, the various branches of industrial progress. The magazine is interesting and occupies about the same field as Cassier's Magazine in this country. Our comments with reference to it would be more favorable were it not for the fact that the publisher is evidently over sanguine of the future success of his magazine, or at least is apparently well satisfied with his present efforts, which we take to be a bad state of mind for a publisher to be in. There are several editorials containing passages like the following: "We can say with confidence that never before in the history of the trade press has such a storm of congratulatory and eulogistic comment been showered upon a new industrial publication." "It is something to be grateful for, that even in 'effete' England such a publication as this was wanted. We present the first issue with the confidence that we have produced a magazine fully up to our expectations."

### ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9 X 12, 6X9 AND 3½ X 6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

The Cleveland Twist Drill Co., Cleveland, O., have sent us a complimentary copy of the Mechanics Pocket Memoranda, the excellent pocket-book issued by the International Correspondence Schools, Scranton, Pa. This book makes a very attractive and valuable advertising souvenir that will be appreciated by the many friends of the Cleveland Company who are fortunate enough to receive a copy of the book.

A large and handsomely gotten up catalogue is that issued by the U. Baird Machinery Co., Pittsburg, Pa. It contains 232 large pages printed on heavy paper, and the illustrations are much finer than those usually shown in catalogues. The line of tools includes a great variety of lathes, planers and other standard machine tools, hoists, air motors, electric motors, air compressors and many other tools and appliances.

C. H. Besly & Co., Chicago, Ill., dealers and importers of machinery, have issued a catalogue of 300 pages, which is very complete, containing as it does illustrations, descriptions and price-lists of about everything required about the shop, in the way of small tools, appliances and materials. The matter is very much condensed, with small illustrations, so that many more articles are listed than would usually be found in a catalogue of twice this number of pages. It is a handy book to have for reference.

Watson, Stillman Co., New York City, have issued a catalogue of hydraulic jacks and tools in which are shown a few of the hundreds of hydraulic tools made by them. Their system of cataloguing tools consists of issuing sheets on each of which are shown one or two tools of a similar nature. This catalogue contains about fifty of these sheets bound into pamphlet form. At the back there is an index of the other illustrated sheets, from which descriptions of any of their tools can be ordered.

We have received from the B. F. Sturtevant Co., Jamaica Plain, Boston, Mass., Bulletins H and I, describing, respectively, their monogram motors, as attached to fans and their eight-pole motors and generators.

MACHINERY.

Vol. 6. November, 1899. No. 3.

# THE SHOPS OF THE BETHLEHEM STEEL COMPANY.

## ILLUSTRATIONS AND DESCRIPTIONS OF SOME OF THE NOTABLE TOOLS USED FOR MACHINING THE FORGINGS MADE AT THESE WORKS.

Of no less interest than the production of steel forgings at the plant of the Bethlehem Steel Company, as described in the last number of the paper, is the machining of such forgings in the extensive shops of these works.

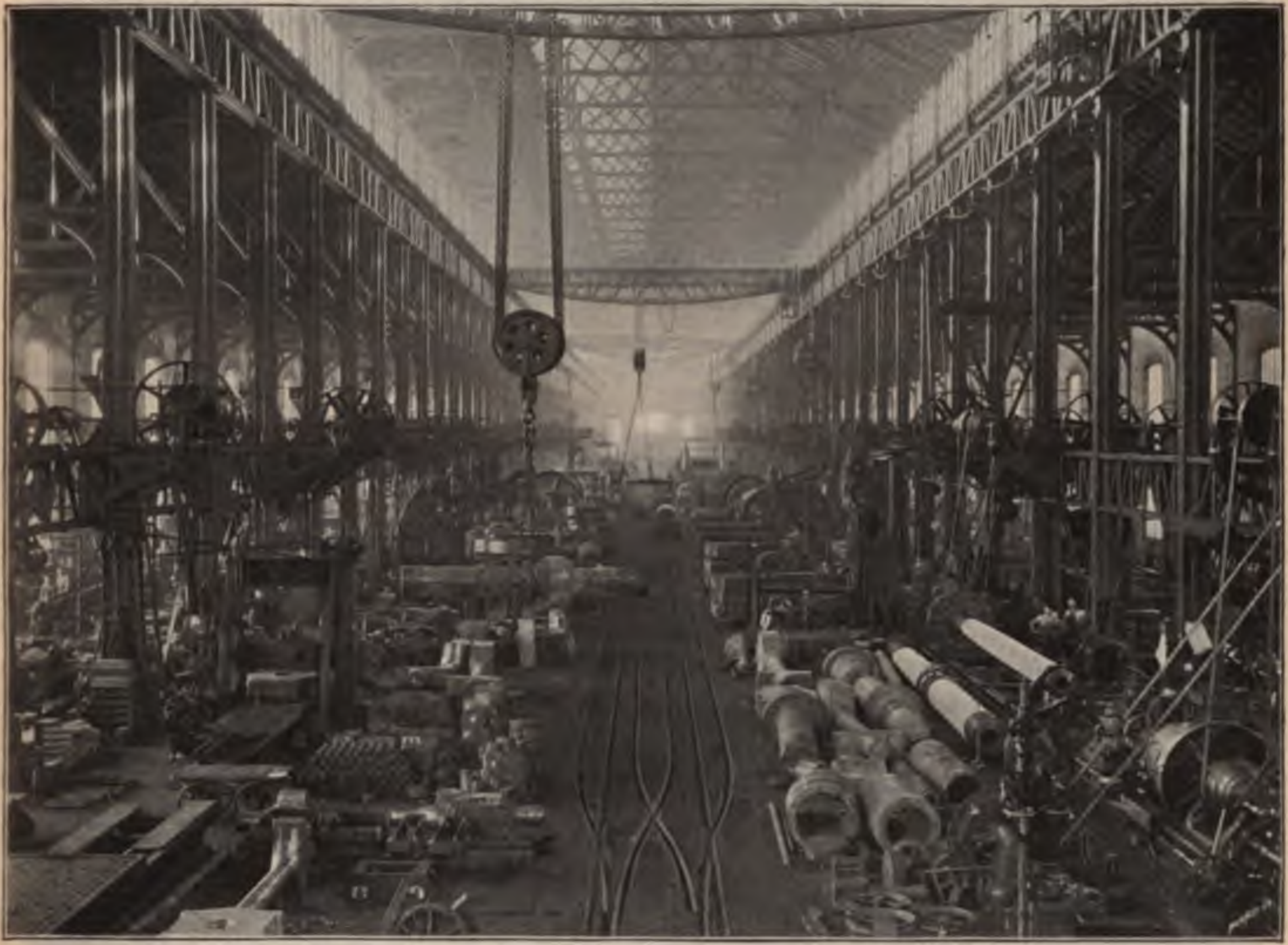


*Fig. 1. Main machine shop of the Bethlehem Steel Company. It is 1375 feet long, 117 feet, six inches wide and is probably the longest single shop building in existence. The central span is served by six traveling cranes ranging from 75 tons to 25 tons capacity, and the wings by four traveling cranes. Here are located the tools and appliances necessary for machining the forgings for the heavy guns, engine shafts and other machine parts, as well as for turning out other lines of work of the most massive character.*

On this page is shown a general view of machine shop No. 2, where the bulk of the work is machining forgings for guns and such general forgings as large shafts and other engine and machine parts. Complete guns and gun carriages are manufactured here, ranging in size from the 12-inch "peace-maker" to the 4-inch rapid-fire gun which did such terrible execution at Santiago. Work of this character, together with the general machine work that a large firm inevitably has to do, is sufficient to require a shop building over a quarter of a mile long and over 117 feet wide, probably the largest shop building in the world, and the exact dimensions of which are given in the caption under the illustration. In this shop has been done such large work as the machining of the forgings and castings for the 125-ton hammer owned by this company, the most powerful hammer ever made, and the top and bottom heads of the hydraulic press shown on page 35 of the last number, weighing 135 and 120 tons respectively, besides other heavy presses and tools of phenomenal sizes. The shop methods, tools and machinery to be seen here present many attractions to the man of the machine shop; but still more unusual, and for that reason of still greater interest to the average mechanic, is the machining of the forgings for armor-plate, which is done in machine shop "No. 3." This building, although smaller than the other one, is 775 feet long and 120 feet wide in the main portion. The equipment is entirely of massive machinery, of a kind that is seldom seen, most of it having been either imported from the Creusot works of France, or made by the Bethlehem Steel Company themselves. The writer was shown one plate for the front of one of the turrets of the Alabama that measured 20½ x 11½ feet and was 14 inches thick. This is one of the largest plates ever made, and indicates the capacity of the plant better than any description that could be given.

### The Main Shop.

The main machine shop, which is shown in the illustration, is of steel construction and is built with one central span and two wings, one on each side. The central span is 60 feet wide, and short lengths of shafting are supported by the columns on each side and are driven by six 12 and 24 by 24 compound engines,

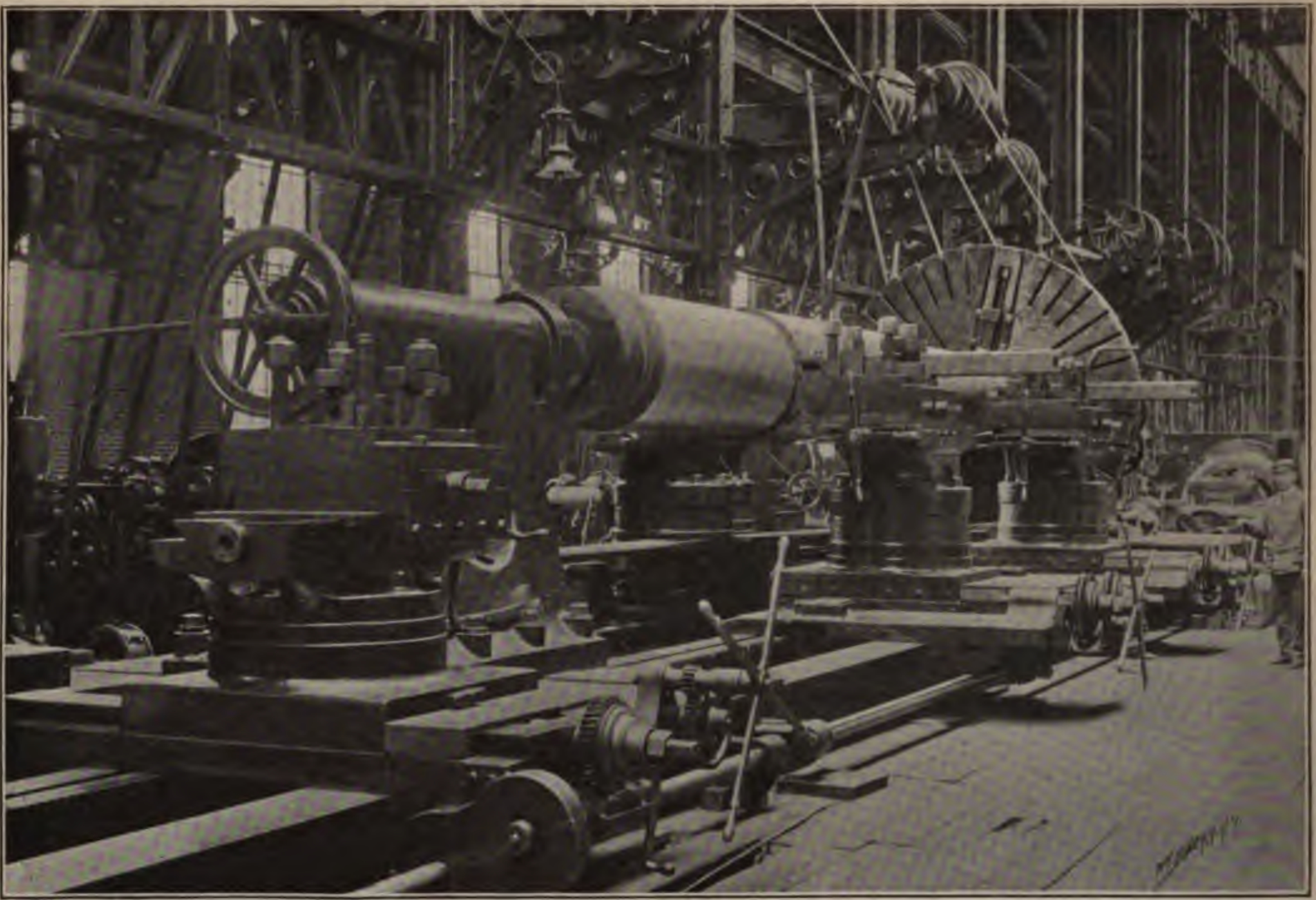


*Fig. 2. Screw-cutting engine lathe in "machine shop No. 2," for turning heavy guns and shafts. Face plate 120 inches in diameter and swing over shears 130 inches by 76 feet. It is geared for turning taper from one in ten to one in 400, and there are four carriages with compound rests. Besides this lathe there are five in the shop, with 120-inch face plates and of 100-inch swiug. The shaft shown in the lathe weighs 65,000 pounds and is 37 inches diameter at the center and 27 feet 4 inches long.*

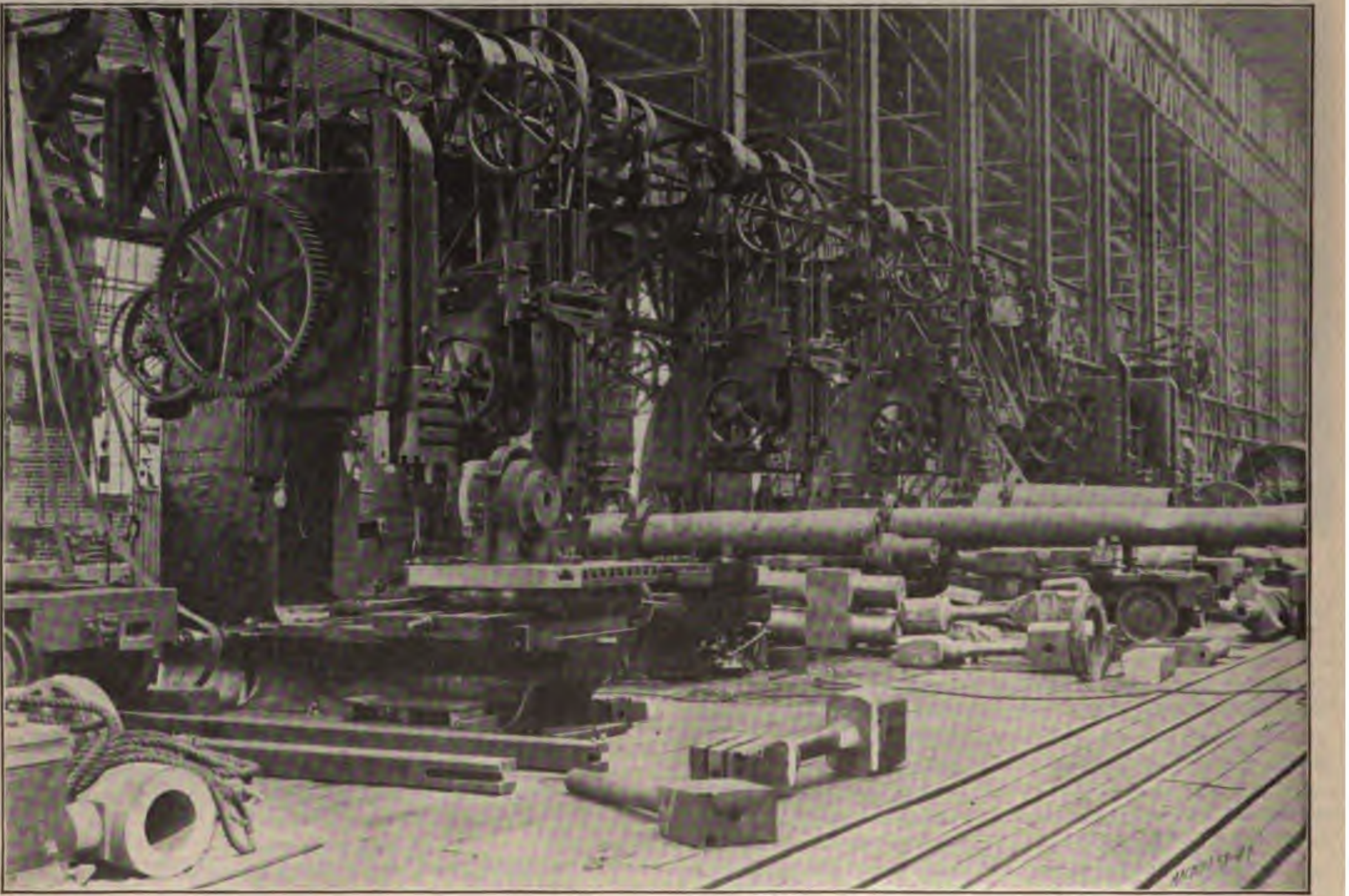


*Fig. 3. Row of 60-inch slotters. In machining forgings such as connecting-rods and cranks, in cutting out test pieces and squaring up the ends of forgings, the slotter is a necessary tool. There are five of them in the row shown and on the other side of the shop are six more of 36-inch stroke. All of these are kept busy and make a remarkable collection of machines.*

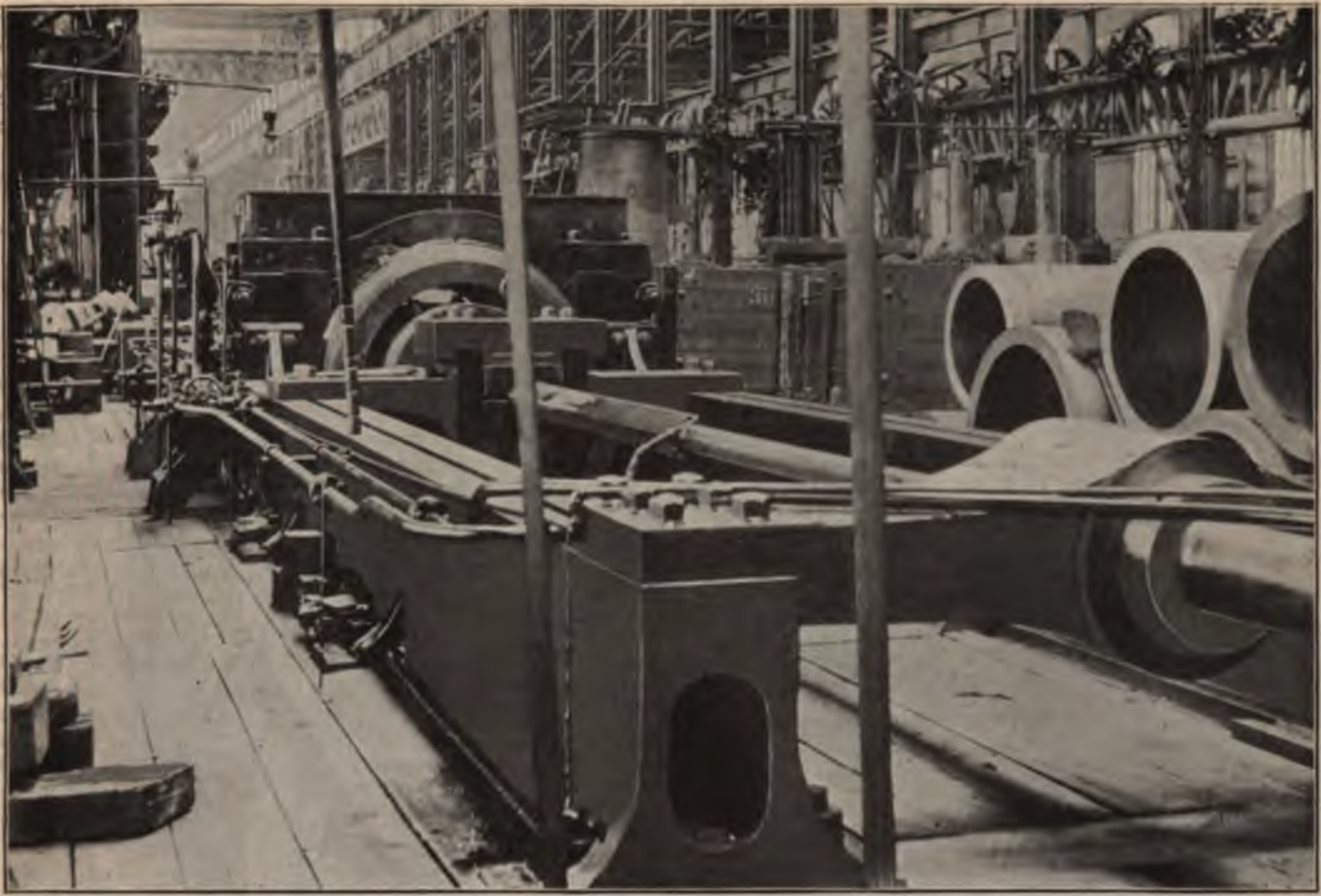


*Fig. 4. Ingot boring mill, with hydraulic feed. The driving head is in the center and there are two boring bars, one at each end. With this machine a hole can be bored 25 feet long. The head will take work 54 inches in diameter and a hole can be bored 20 inches in diameter, from the solid, by starting with a flat drill and finishing with inserted cutters.*

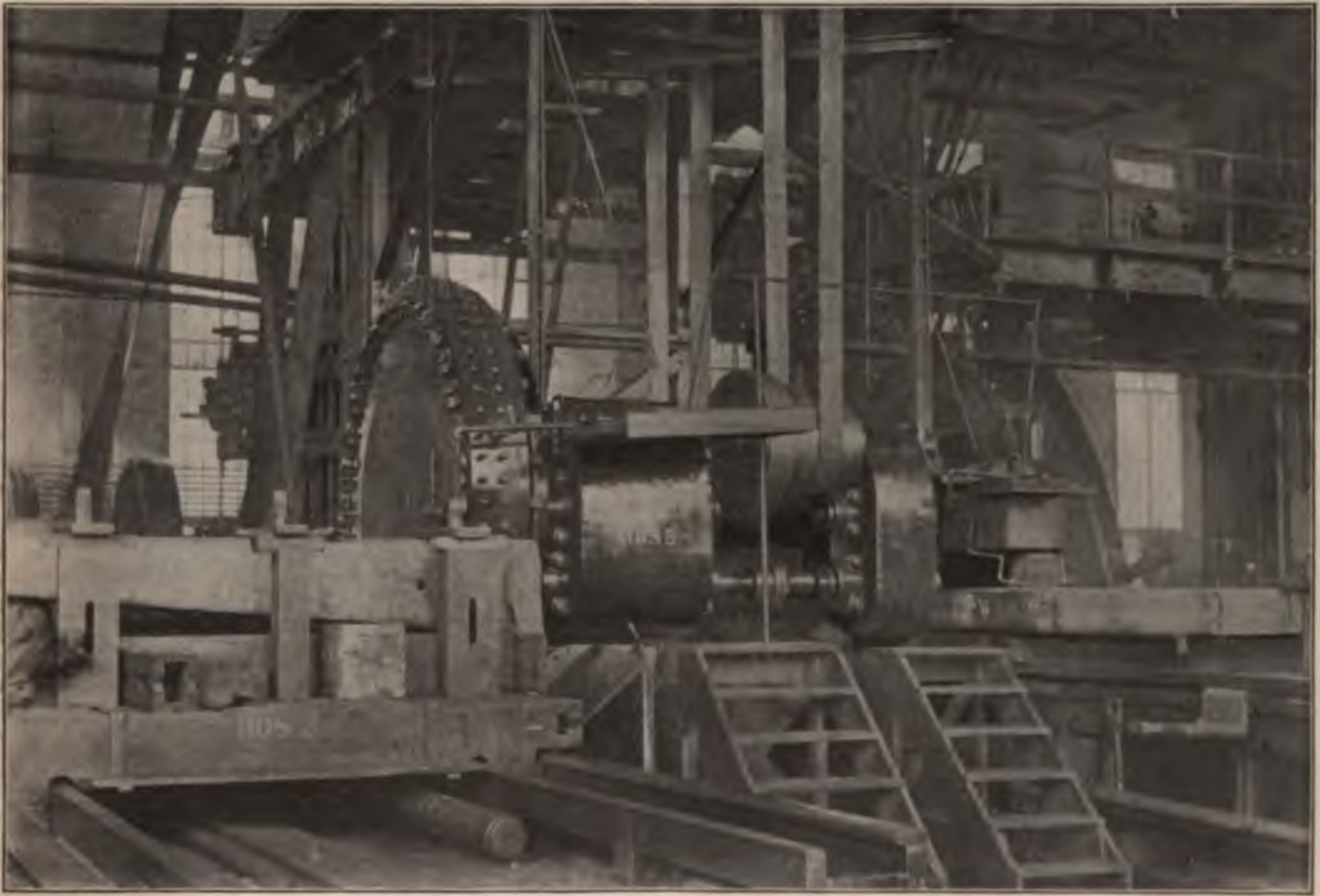


*Fig. 5. Rotary planer and saw, operating upon armor plate. The cutter-head and saw are 84 inches in diameter and the tables have a travel of over 30 feet. This powerful machine was built at the Bethlehem works for the heaviest class of armor-plate work, up to 30 inches thick.*

ranged at intervals down the shop. There are three lines of track running through the shop, one of standard gauge for freight cars and two of narrow gauge for shop cars. The main part of the shop is served by six travelling cranes of from 25 to 75 tons capacity, four of which are electric and the other two are pneumatic, but are to be converted into electric cranes.

Those who have seen the forgings furnished by the Bethlehem Steel Company to firms in different parts of the country know that they are received "rough turned," or with the bulk of the surplus stock removed, leaving the piece so that it at least resembles the shape that it will have when finished, which is not always the case with forgings in the rough state. All of this roughing is done in this shop, and it would be an eye-opener to most mechanics who have attempted to work high carbon steel, and especially gun steel, to see with what ease and speed the mechanics here succeed in peeling off the chips. It is our impression that the speeds used are fully 50 per cent. higher than we have seen elsewhere on similar work, and it is due, no doubt, to three causes. First, the machine tools are heavy enough to stand up to the work; second, a long series of experiments has been conducted to determine what brands of tool steel are exactly adapted to the requirements; and third, soda water is used freely, the tools being flooded with it. An extensive soda water system is now being installed, with a view to having this lubricant easily accessible at any point of the shop. Cement flooring is being put down, draining toward the center of each machine, from which points the soda water is conducted to central tanks. It is also arranged so that any overflow will run toward the center of the shop, where it will drain to the tanks. Pipe lines are being put in, with suitable connections to the different machines, and the supply is kept up by pumps which draw from the central tanks. This system is the most complete and elaborate of its kind that we have heard of, and it could be adopted on a smaller scale by many shops with profit. It would increase the speeds and feeds enough to pay a good interest on the investment, if, indeed, the first cost were not wiped out within a short time.

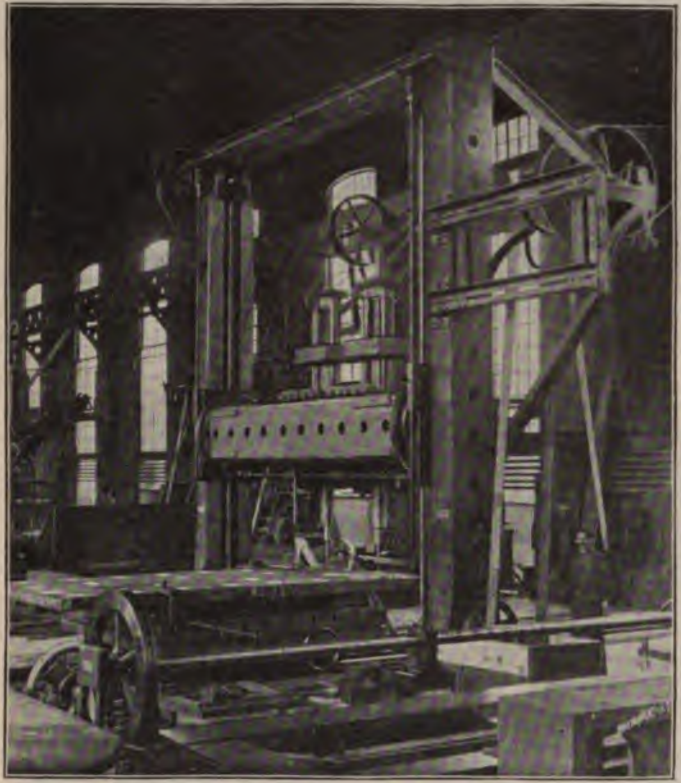


*Fig. 9. Bement, Miles & Co. double drill press. There are five of these machines that are capable of drilling or boring in any direction in any plane. The table also has a feed so that the machine can be used for milling. Two of the machines have a capacity of 17 x 20 feet, one a capacity of 14 x 17 feet and two of 14 x 14 feet. The dimensions can be best appreciated by comparing with the machinist standing at one side.*

Besides roughing out forgings for other companies to finish, this company finishes hundreds of forgings that are too large or complicated for other shops to handle efficiently. Since open-hearth fluid-compressed steel has been available for engineering work, the demand for it has grown steadily, and engine builders and others place orders for shafts, connecting-rods and other parts to be forged and made here complete, ready for shipment to the point where the plant is to be erected. The extent to which this is done is one of the decidedly modern innovations of engineering, and shows to what an extent specialization is being carried. Shafts ranging from those for ocean liners to those for torpedo-boats and yachts are made, and as great a variety of other pieces. Some of these smaller quadruple throw crank shafts with cranks, crank pins, eccentrics and shafts forged in one piece, and with pins and shafts hollow, are as handsome pieces of machine work as one could wish to see. One of these, for example, was of steel of 60,000 pounds elastic limit, 5 inches outside diameter and 3½ inches inside diameter.

In turning these shafts the method is adopted of facing the flanges, with the shafts turning in regular bearings set up on the lathe ways, so that they rotate under normal conditions and the facing will come true with the axis of the shaft. Aside from the other advantages of hollow shafts and crank pins, this feature is of advantage in turning the pins of such shafts, since a bar can be run through one of the hollow pins, and, by suitable centering blocks at the ends, the shaft supported very nicely on the bar, which is then placed between centers.

### Boring Long Holes.

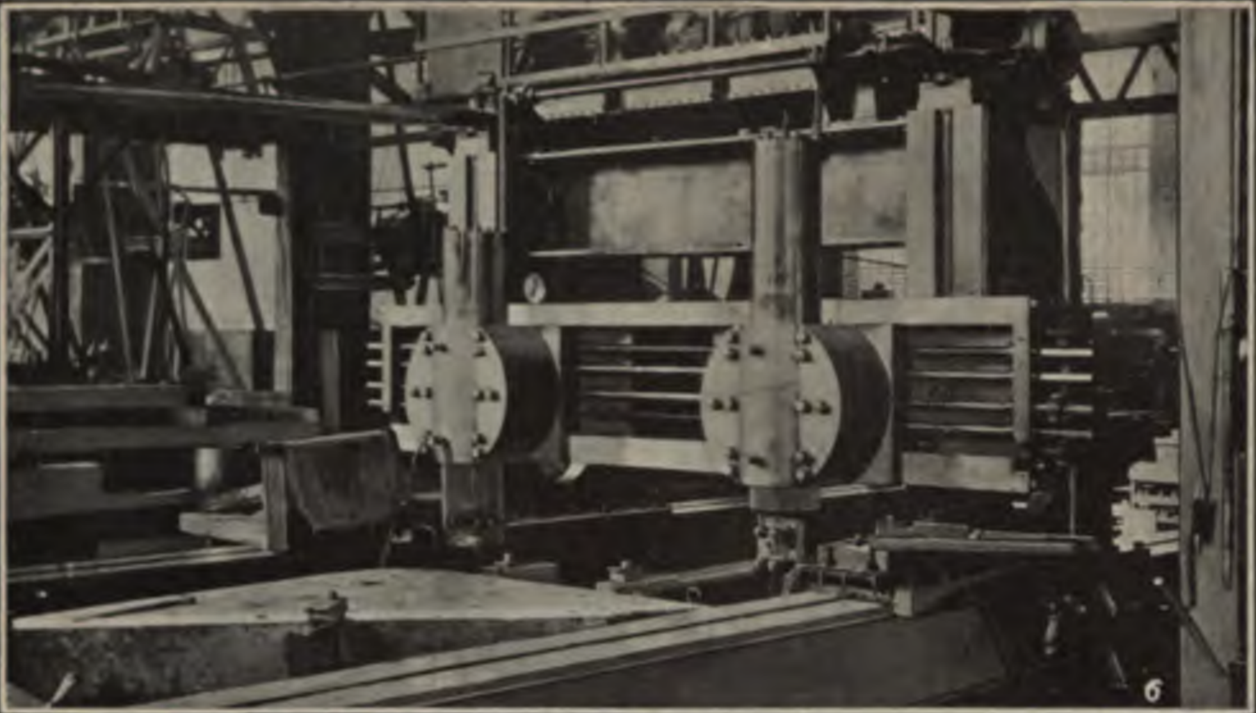
Perhaps as interesting work as any that is done in the shop is boring out the centers of the solid ingots, from which shafting, gun-hoops and other hollow forgings are made; and also the boring of shafting and other long pieces. One of the machines for boring, or more properly, for drilling ingots, is shown in Fig. 4. The boring head is of a very simple character, consisting of a two-bladed cutter inserted in the end of the bar—in reality, nothing more nor less than a modification of the old-fashioned flat drill. The edges of the drill are grooved to break up the chips, and back of the cutter, teeth are inserted in the bar to bore out the hole started by a drill to a larger size. To drill a 5- or 6-inch hole through a steel ingot several feet long, at the same time boring out the hole to a still larger size as the drill progresses, and to have these operations going on at the two ends of an ingot simultaneously, requires a degree of rigidity that is seldom found, and a power and evenness of feed that can be obtained only by hydraulic pressure. The degree of feed is regulated by varying the hydraulic pressure through the medium of a by-pass.

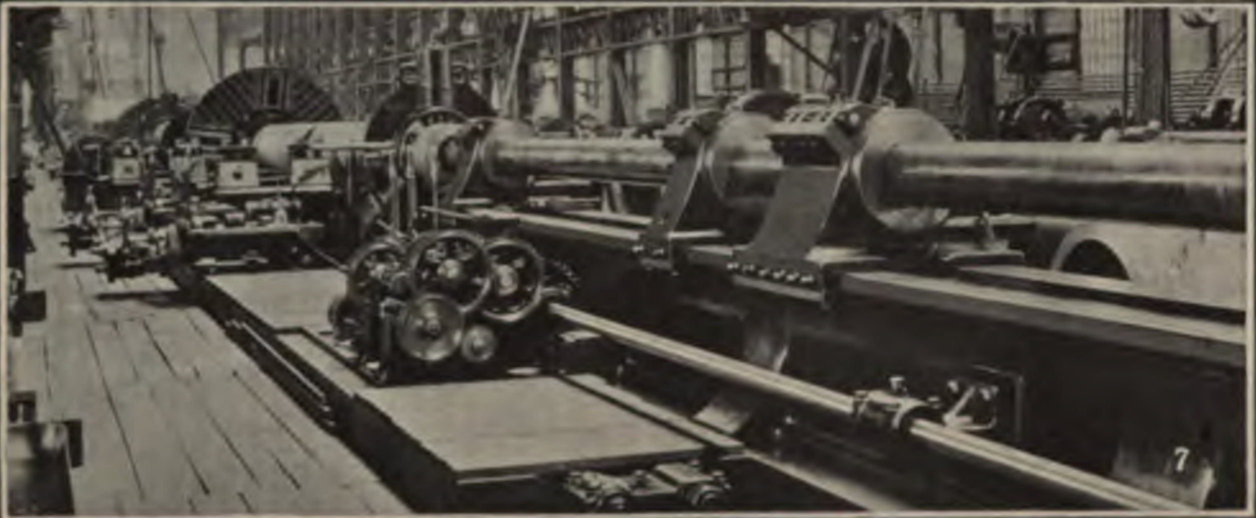
There are in all nine large boring machines in the shop for boring long holes in pieces ranging from 54 inches in diameter down to smaller sizes. There are also three small Pratt and Whitney machines for boring holes through small shafts, spindles, molds for printers' rollers, etc. These twelve machines are in addition to five gun lathes, for 12-, 10-, 8- and 5-inch guns, which are fitted for both boring and drilling. It is claimed that a hole 60 feet long, such as might be required in a marine engine shaft, can be bored and finished true within small limits, the holes being drilled thirty feet from each end and meeting with no appreciable shoulder after the finishing cut has been taken. This may seem incredible, but it must be remembered that the material operated upon is of uniform texture throughout and that a "hog bit" is used, which experience has demonstrated will do remarkable work if there are no blow-holes or irregularities of the material to throw it out of its course.

### Large Tools.

The pit planers in use here, one of which is shown in Fig. 6, possess features that make them valuable tools for extremely heavy work, where the mass is so great that it would preclude having the work itself move and the tool stationary. The planer in the main shop has a capacity of 10 by 14 feet through the uprights and will plane 30 feet long. The pit itself is 12 feet 9 inches by 44 feet and 14 feet deep. The planer was built at these works to machine the parts of the large hammer referred to and the large forging and bending presses described in the last number. At present it is used for any of the larger work, such as planing the frames of the carriages for coast-defense guns.

While speaking of large planers it will be of interest to state that they are now building for the armor-plate shop a so-called "cross-cut" planer that will take at one time plates having an aggregate surface of 20 by 30 feet. The foundation for this machine is 40 by 56 feet.





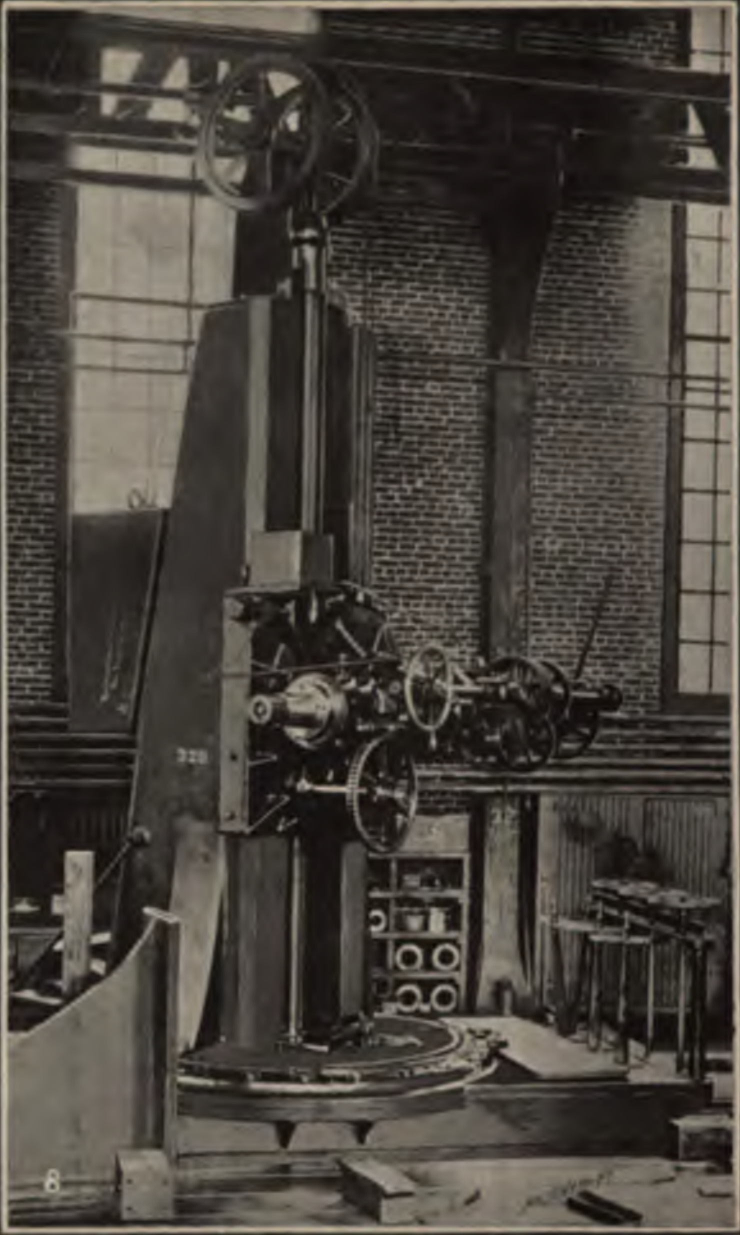


*Fig. 6. Pit planer in armor plate shop. There are two of these planers, with a capacity of 10 x 10 x 30 feet, and in the main machine shop is one of still larger size. The work remains stationary and the cross rail and uprights are driven by two longitudinal screws, one at each side, and slide upon the ways shown at the sides of the planer.*

*Fig. 7. Twelve-inch gun lathe in the machine shop, for boring and turning the coast defense guns. The traverse and feeds of the carriage and the feeds of the boring bar are all operated by handles and levers. In turning work the operator rides on a platform attached to the carriage and has every motion at his command through these levers.*

*Fig. 8. Bement, Miles & Co. milling machine in Shop "No. 3." This is a universal machine for milling, boring and drilling and is used for finishing the edges of port holes in armor plates. The column swivels on the base and the head swivels on the saddle. The vertical travel on column is ten feet and the horizontal travel on bed plate 30 feet.*

As a matter of record, we will state that the longest lathe in the shop will take 80 feet between centers, the longest boring machine will bore a hole 60 feet long, and the largest lathe and drill are described sufficiently in connection with the illustrations 2 and 9.

### In the Armor-plate Shop.

When an armor-plate has been finally treated, its face is so hard that it is impossible to drill or otherwise machine it by any ordinary means. Such work must be done before this final treatment takes place, and so these plates are first brought to approximately the right size, and if any openings, such as port-holes, are required, these are drilled out previous to the hardening. After hardening, the backs of the plates are still soft enough to be worked, and the edges at the back can be milled down to the exact dimensions to within a few inches of the outer face, and then this remaining face must be ground off. The grinding machine, therefore, plays an important part in the manufacture of armor-plate, and is even more necessary here than in ordinary shop practice, where it is now generally termed a necessity. There are five grinding machines in the armor-plate shop of special design for this work.

The most striking tools in the armor-plate shop are the rotary saws, of which there are four, that trim the edges of the plates. These machines were imported from the Creusot works, France, and will saw a plate 24 inches thick and 33 feet long. The body of the saw is 84 inches in diameter and has 76 inserted cutters, which alternate wide and narrow to more readily break up the chips and prevent binding. Each saw is driven by a worm-wheel 90 inches in diameter.

The combined rotary planer and saw illustrated in Fig. 5 is a more powerful tool than the others, and was designed and built by the Bethlehem Steel Company. It has afforded a good opportunity to compare the merits of the rotary planer and the saw, and the capacity of the planer has been proven to be such that it will take off metal six inches deep from the edge of a plate 16 inches thick quicker than the saw will take off a strip of the same width and thickness. This is a remarkable machine and it is engaged steadily upon remarkable work.

Besides the grinding machines and the saws, there are in this shop two pit-planers like that illustrated in Fig. 6, the universal milling and drilling machine of Fig. 8, and three drills like those in Fig. 9. These illustrations give a clear idea of the character of the operations to be done upon armor-plate and of the character of the tools required.

The plates have to be planed, finished on their edges and any openings have to be drilled out. They are also drilled and tapped at the back for the standing bolts that fasten them to the framework of the ship. All plates are erected side by side in the shop in their relatively correct positions, just as any machine work would be, and to handle such massive weights requires ample crane capacity. A new use for armor-plates has recently been found in the construction of safe-deposit vaults. One was recently built here with a door having ground joints, and it was calculated that the kind of material that has been found efficacious in resisting an enemy's shots would be, at least, troublesome to an evil-minded person who was trying to get on the inside of the vault without the combination. This construction is vastly superior to composite-built vaults.

* * *

## HARDENING SOLUTION.

Of all the various receipts for hardening compounds, I have never really known of but one that was of any practical value.

A solution of chloride of sodium in water will make the water a much better conductor of heat and will therefore cool the piece off quicker. The result is that you get the steel much harder and at a lower heat than with clear water. There is also a slight chemical action which causes the scale to drop off, and the piece comes out of the bath considerably cleaner.

The chloride of sodium should be in a cloth bag, hung near the top of the tub, and the water will gradually take up a considerable quantity of it.

P. S.—The above is written for the benefit of those who are not satisfied unless they have something very mysterious and scientific. To those who are satisfied with the plain old common-sense rules, I would say that chloride of sodium is nothing more nor less than common salt.—"The Professor" in "Sparks from the Crescent Anvil."

## WIRELESS TELEGRAPHY.

### AN EXPLANATION OF THE PRINCIPLES OF THE SYSTEM USED BY MARCONI IN REPORTING THE RECENT RACES FOR THE AMERICA'S CUP.

WM. BAXTER, JR.

Wireless telegraphy is looked upon by the popular mind as the greatest of all electrical mysteries, and, further, it is believed to be an achievement realized only within the past few months. As a matter of fact, the action is not in the least mysterious, and can be readily understood by any one when explained in simple language; and it is not an entirely new development. There are three ways known, at present, in which wireless telegraphy may be accomplished, but in this explanation we will confine ourselves to the system used by Marconi, which is the one that has been brought to the highest state of perfection, and, in fact, the only one that can be said to be commercially successful. Wireless telegraphy has been experimented with for many years, but it was not until about fifteen years ago that any practical results were obtained. In 1884 messages were sent through underground wires, were read upon telephonic circuits located eighty feet above them, and in the following year speech by telephone was carried on over a distance of about one mile and a quarter. In 1892 messages were transmitted over a distance of more than three miles. Marconi's experiments began in 1896, and up to the present time he has succeeded in transmitting messages to a distance of about 30 miles. Most of the apparatus used by Marconi is old and was invented by others, nevertheless he has obtained results far greater than any one else, and the difference appears to be due to the addition of a vertical wire, varying in length from 20 to 100 feet or more, according to the distance to be covered. Thus, it will be seen that in this case the difference between small and great results depends upon a very small thing—a few feet of wire—but this does not in any way detract from the credit due to the inventor for having obtained results far greater than any of his predecessors; in fact, the simplicity should only add to the credit he is entitled to.

In order that the principles of wireless telegraphy may be understood, it is necessary to disabuse the mind of the popular notion with respect to the nature of electricity, for, so long as this remains, a correct insight of the subject cannot be obtained. Electricity is generally regarded as a mysterious fluid that possesses the power of flowing at an enormous velocity and in great quantities through wires, just as water flows through pipes. When a man looks at a trolley car running along the street at a high rate of speed he pictures in his mind's eye a tremendous amount of electric fluid flowing through the trolley wire from the generator in the power station to the motors under the car. He can hardly realize how this incomprehensible fluid can travel along the wire without producing any noticeable effects, but he sees the car and the trolley wire, and knows that the power that moves the former comes from the distant power house and comes over the wire; hence, although he cannot see how the fluid gets through, he knows that it gets there. When he tries to unravel the mysteries of wireless telegraphy by the same process of reasoning he becomes hopelessly entangled, for he cannot understand in what way the mysterious fluid can cut through space from the sending to the receiving station; he wonders why the fluid will not go in the opposite direction, or in any other direction just as well. The first step to take to remove all confusion is to understand that electricity is not a fluid, that it is not a material thing, but simply a force of nature that is made manifest whenever the minute particles of matter are set in motion in a certain way. In other words, electricity is a force which is the result of a certain form of motion.

It is difficult to understand at a first glance how a form of motion can account for the transferences of hundreds and even thousands of horse-power over long distances, but such an action can be readily illustrated. Suppose we have a trough ten feet long, and say five inches wide and of equal depth and filled with water. If we agitate the water at one end with a paddle we will produce waves that will travel to the other end. If at the distant end we place a float, it will rise and fall with the waves as they roll in from the sending end, and if the float is connected with the plunger of a pump, it will move the latter and thus pump water. Here we have a simple illustration of the manner in which the wave motion imparted to the water by the paddle at one end will cause a float to bob up and down at the other end of the trough and thus operate a pump; hence, we have a transference of the power applied from the paddle at one end to the pump at the other end, and all accomplished by the wave motion imparted to the water. If the trough is made two or three hundred feet long and correspondingly wide, and the water is agitated by a sufficiently powerful paddle, a pump of large size can be operated at the distant end. Now, if power can be transferred from one end of the trough to the other by means of the wave motion imparted to the water, why cannot the same result be accomplished by propagating a wave motion through or along a wire connecting an electric generator with an electric motor? The modern theory of electricity says that it can, and this is the way in which energy is transferred in an electric conductor. Light, according to the modern theory, is also produced by wave motion, but the waves are very short, being, in fact, of microscopic dimensions.

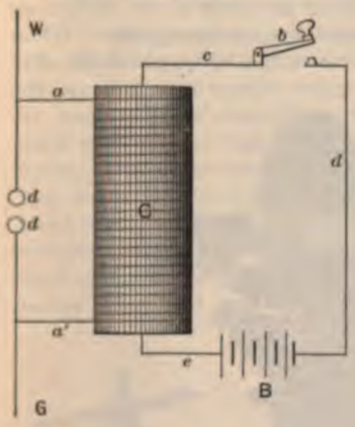


FIG. 1

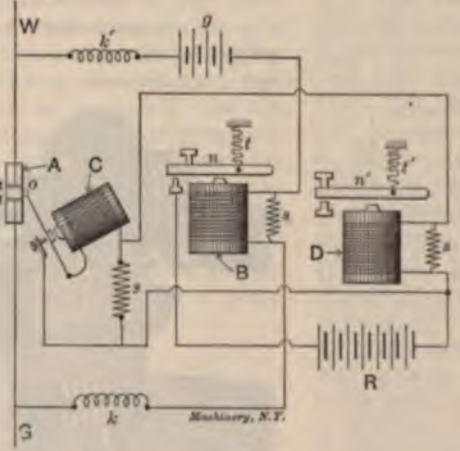


FIG. 2.

About thirty years ago, Prof. Clark Maxwell advanced the theory that light and electricity are of the same nature, and that the only difference between them is in the length of the waves. About ten years ago Prof. Hertz proved experimentally that Maxwell's theory was correct, this proof consisting in the production of an apparatus, called a Hertz oscillator, which develops electric waves that radiate into space in precisely the same way that light rays do. The rays of light emitted by a lamp can be seen by the human eye, because the latter is so constructed that it is affected by light radiations, but the eye cannot see the electric rays emitted from a Hertz oscillator simply because it is not so constructed as to be affected by them. Telegraphing through space by means of powerful lights would not be considered anything wonderful, because the eye can see the light if there is no obstruction in line with it. Now, to telegraph through space with electricity, all we have to do is to provide a Hertz oscillator to develop the electrical radiation at one station, and a device capable of detecting this radiation at the other station. In other words, the sending instrument at one station must be so made as to produce an electric radiation, and the receiving instrument at the other station must be so made as to see this radiation—that is, it must be an electric eye.

The way in which all this is accomplished in the Marconi system can be explained in connection with the diagrams Figs. 1, 2 and 3. Fig. 1 shows the transmitting instrument. C is an induction coil, the same in construction as those used in medical batteries to give shocks, but very much more powerful. An induction coil, it may be well to state, is a device employed to obtain, by means of a current of low pressure, another one of very high pressure. The low-pressure current used is of large quantity and may be compared to a large stream of water moving with a small velocity, while the high-pressure current is of very small quantity, and can be compared to a very small stream of water flowing through a small pipe, but with a very high velocity. The low-pressure current is called the primary, and the high-pressure current is called the secondary. The coil is wound with two separate wires, one for the primary and one for the secondary; the primary coil is made of large wire—say No. 16—and has a small number of turns, generally about as many as will go in two layers. The secondary coil is made of fine wire, about as thick as a hair, and consists of many thousand turns. In Fig. 1 the ends of the primary are connected with the wires c and e, which form part of a circuit in which are located a battery B and a telegraph key b. When the key b is depressed the circuit is closed and a current flows through the primary coil wound on C. This primary current induces a secondary current in the fine wire coil, wound on C, and this current passes by wires a a to wires W and G. The latter wire is connected with the ground and W is connected with a wire that runs vertically up into the air along a supporting pole. The wires G and W terminate in two metallic balls d d, which are placed about one-half of an inch apart. When the key b is depressed, the secondary current induced in the induction coil C passes to the wires G and W, and not finding an outlet through the ends of these, jumps across the space between the balls d d. In consequence of this action the wire W becomes a center from which electrical radiations emanate, and as the upper end is high above surrounding objects the rays can reach to a considerable distance in every direction. If at any point within the range of the radiation an electric eye, or receiving instrument, is placed, it will see the radiation. So long as the key b is held in the depressed position the wire W will emit rays, but these will disappear the instant the key is raised. From this it will be seen that by depressing b at proper intervals and for suitable lengths of time, signals can be transmitted that can be readily detected at the receiving station.

The instrument at the receiving station is illustrated diagramatically in Fig. 2, and the important part of it, that is, the electric eye, is shown on an enlarged scale in Fig. 3. The wires G and W are arranged in this instrument in the same way as in the transmitter—that is, G is connected to the ground and W is run up a high mast. The balls d d of Fig. 1 are replaced by the tube A. As will be seen, the wire leading from W passes through k', which is an inductive resistance, thence through a battery g, a magnet B, and another inductive resistance k, and then taps wire G. The tube A, as clearly shown in Fig. 3, holds two wires with flanged heads. These heads are some distance apart and the space between them is filled, loosely, with metal filings. These filings when in the normal state offer a very high resistance to the passage of an electric current, but after a current has been established, the resistance falls down to nearly nothing. The battery g cannot force a current through A, in Fig. 2, as the pressure of the current it generates is not sufficient for the purpose, but when the electric radiation from the sending station strikes the wire W it induces therein a current of very high pressure and this is capable of breaking through the resistance of A. As soon as this high-pressure current passes through A the resistance drops down to practically nothing, and then the current from the battery g follows up. This battery current passes through the magnet B and causes the latter to attract the lever n and thus the circuit, in which the battery r is located, is closed. This circuit contains the magnets C and D; the first one acts to vibrate the lever upon the end of which is located the knob o, and the second one actuates the sounder key n'. The tube A, if not disturbed after it has been traversed by an electric current, will remain of low resistance, but it would not do to have it act in this way, for then the current of the battery g would continue to flow and the sounder D would keep up a continuous rattle. If, however, the tube A is rapped gently after the current has passed through it, it returns to its natural state, in which, as we have said, its resistance is very great. It is on this account that the striker o is provided. This is operated by the magnet C and is so adjusted that it strikes the tube every time the current passes through it; therefore the battery g can-

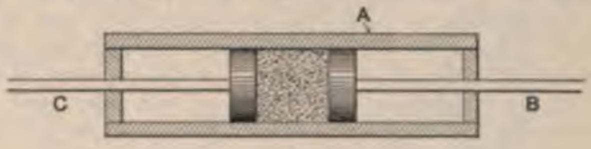


FIG. 3.

not send a current through the circuit except while the current induced in the wire W by the radiation from the sending station, is passing. The tube A is called a coherer, but it is also referred to as an electric eye. It is made of glass and is about one inch and a half long and about one-eighth of an inch inside diameter.

The magnet D can be dispensed with if it is not desired to record the signals on paper, for the vibrator o acts as a sounder and the signals given by it could be easily read by a telegraph operator. In the Marconi system the messages are marked down on paper, in dots and dashes, after the fashion of the Morse instruments of days gone by, but if wireless telegraphy becomes common it is more than probable that the sound system used in regular telegraphy will be adopted.

From the foregoing explanation it will be seen that there is nothing mysterious about the operation of wireless telegraphy; it simply consists in using, for a sending instrument, a device that is capable of emitting electrical radiations, and for the receiving instrument a device that is acted upon by these radiations.

The possibilities of wireless telegraphy have been greatly exaggerated by the sensational press. It has been asserted that it would supersede the present methods and that before long messages would be transmitted across the Atlantic and that many other impossible things would be done. As a matter of fact, however, wireless telegraphy is limited to a certain sphere. A light located upon a prominence can be seen by any one within range of it, no matter on what side he may be located, and so with wireless telegraphy; any receiving instrument placed within the range of the transmitter can receive the signals; hence there could be no privacy with it, as an unlimited number of stations could be located so as to receive the message from a given transmitting point. From this it can be seen at once that if ten or fifteen transmitting stations were located within range of each other and within range of several receiving stations, there would be an endless confusion, as each receiver would be acted upon by several transmitters at the same time. It has been proposed to get around this difficulty, in a measure, by using reflectors and focusing the rays in the same manner as the light rays are focused with search-light projectors on board ship, but, so far, it has been found that when reflectors are used, the distance to which the signals can be transmitted is reduced to about four or five miles, so that by this expedient privacy is obtained at the reduction of distance. When reflectors are used the wires W and G are discarded, and the reflectors are placed back of the balls d d, in the transmitter, and back of the coherer A in the receiver. The two instruments are then placed at a considerable elevation so as to be within each other's range when located at the points desired.

It has been asserted by some writers that wireless telegraphy can only be made to operate between points that are in sight of each other, and that on that account the vertical wires W would have to be made of sufficient length to compensate for the curvature of the earth. The experiments of Marconi, however, prove that this conclusion is not correct, as in several instances he has maintained communication between points that were hidden from each other by intervening hills, and, in at least one instance, the distance between the stations was such, relatively to the height of the wires, that the curvature of the earth placed the stations out of sight of each other, and the electrical rays, if they passed in straight lines, must have pierced the surface of the earth. According to Marconi's practice, the wires W are made twenty feet high for a transmission to a distance of one mile, and for greater distances the distance is increased as the square of the height of the wire, so that with a wire 40 feet high the distance between stations can be four miles, and with wires 80 feet high the distance can be 16 miles, while with wires 160 feet high the stations could be 64 miles apart.

* * *

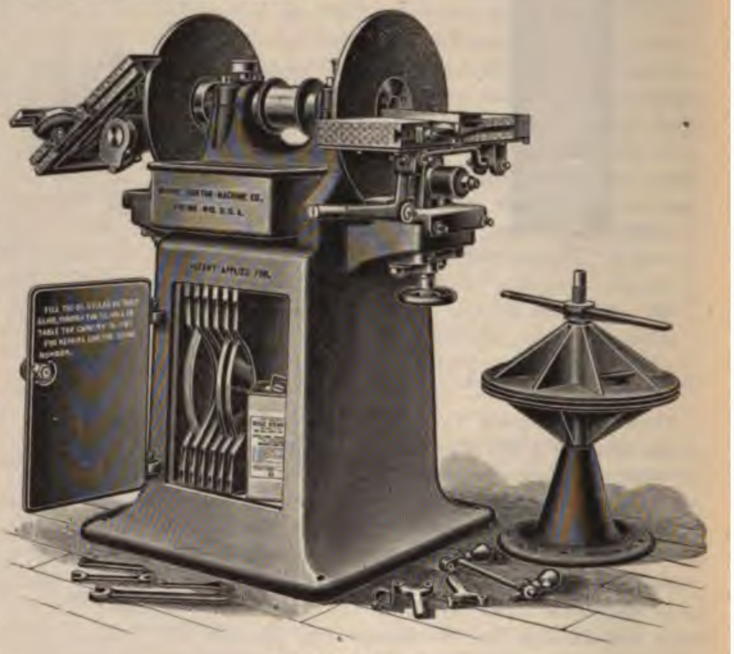
It is evident that the gospel of plenty of light in machine shops cannot be preached too strongly when one notes the many shops throughout the country in which the small amount of light that struggles through the dirty windows is almost entirely absorbed by the grimy walls and ceilings. Plenty of light encourages industry, enables accuracy to be attained, and promotes the efficiency of the entire shop.

## UNIVERSAL DISC GRINDER.

We have previously called attention in these columns to the advantages which disc grinders having smooth metal discs, covered with emery cloth cemented to their faces, possess for a great variety of work.

Comparatively few years ago it was considered essential that all the finished parts of machines should be filed and rubbed down by hand, and while this process produced superior results, it was the most expensive work put on the machine and at points where expense was entirely unnecessary. Later, buffing and polishing wheels and straps came into use and greatly reduced the cost of polishing, but had the objection that they would not produce true and even work.

The disc grinder is designed for the rapid finishing of metals, the intention being to produce the work with the speed of the ordinary grinder, but with the accuracy of hand and machine work. The emery, being backed by the true and hard surface of the metal disc, presents an accurate surface for shaping the work, and, as there is no glazing or grooving of the surface, as with the ordinary wheel, it makes a free cutting grinder. When a sheet of emery is worn out it is simply stripped off the disc and a new sheet cemented on.



GORTON GRINDER

In the accompanying illustration is shown the latest style of disc grinder, as made by the George Gorton Machine Company, Racine Wis., which possesses some new features. It is now a universal grinder. The table shown at the left has a graduated angular adjustment through 45 degrees, and also a lateral adjustment for setting the top plate close to the disc. The vertical adjustment is five inches, and a protractor square is provided which may be secured to either the lower or right edge. The sliding table shown at the right is controlled by means of the hand lever, and all sliding surfaces are self-oiling and dust-proof. This latter feature holds when making adjustments, as well as when operating the tables, since a study has been made of the problem of excluding the dust from the wearing or bearing surfaces of the machine under all conditions. This table also has a protractor square. The work done upon this machine by the manufacturers is the same in quality as that found on regular machine tools, the bearing surfaces being scraped to a fit and great care being taken to have all important surfaces square with the faces of the wheels and the gradations of the protractors accurate.

* * *

It is rather unusual for a steamship to be moved on the water and yet not in the water, but this feat was performed recently in New York harbor in the case of the steamship Richmond, of the Old Dominion line. The vessel was in a balance floating dry dock in Erie Basin, and the dock was towed a distance of about a half-mile to a new anchorage. The Richmond is a screw steamer of the following dimensions: Length, 210 feet; beam, 33 feet; depth, 21 feet 6 inches; gross tonnage, 1,102 tons. The balance dock has a capacity of 3,500 tons.—Marine Engineering.

### CHAPTER 3.—A LESSON IN PROJECTION.

In tinkering up an old steam pump Jones got into so many different kinds of trouble that he will long remember the day. By some "rule-o'-thumb" calculation he conceived that the crank marked A in Fig. 1 should be longer, so as to give more throw. This crank was not slotted, as is now sometimes the case, but was solid, with no way to lengthen it except to make a new one. Jones tossed the offending casting to his blacksmith with instructions to forge a new one two inches longer, "and be quick about it, too; no time to make a pattern and no foundry nearby if we had one." The blacksmith turned out a pretty creditable job, but when it was fitted up it was found to be so long that it struck the cylinder, thereby giving less throw than at first. The reader can see this by referring to the dotted lines in Fig. 1, and Jones might have seen it had he made more marks and fewer remarks. However, he thought he could get around the difficulty by bending the crank, so, picking up a piece of board, he laid the forging down and marked around it, changing his drawing as he progressed until it resembled Fig. 2.

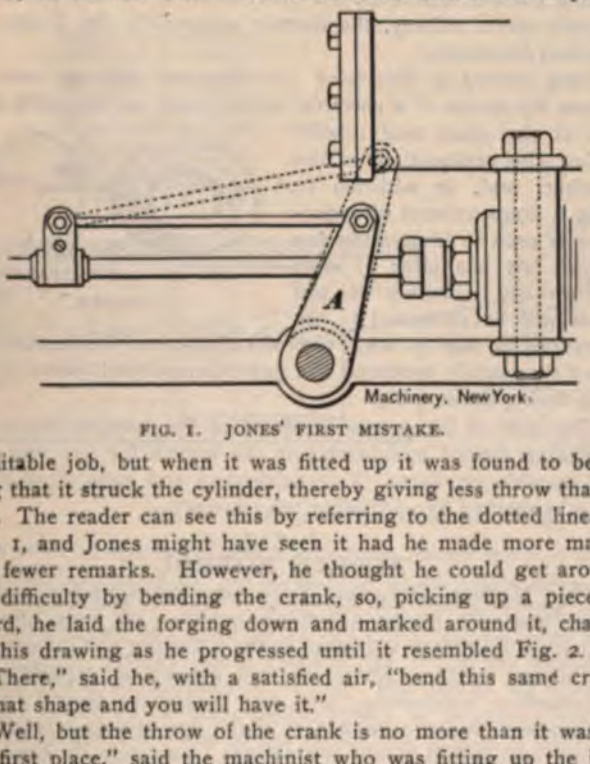


FIG. 1. JONES' FIRST MISTAKE.

"There," said he, with a satisfied air, "bend this same crank to that shape and you will have it."

"Well, but the throw of the crank is no more than it was in the first place," said the machinist who was fitting up the job. The boss seemed to be expecting this answer; at least he was ready with an explanation.

"Now, if you had watched me laying of it out you would see your mistake, 'cause the crank is the same length as before measured on the curve. Now, allus keep your eyes open and your mouth shet; a fellar can learn lots of things that way."

"But it's shorter between centers than it was before 'twas bent, Mr. Jones."

"That don't make no difference; the mollycules kinder follow around the curlycues, so that the longer the lever the more throw you get. Now just look at this old hand pump. Don't you s'pose them fellows know how to make pumps by this time? Ain't that handle curved jest like what we want, and didn't they do it so as to get more throw, jest as we are doing? I tell ye, them folks don't throw away iron nor waste no work without they see something gained by it. Now, you bend that crank jest as I tell you."

The curve was made according to Jones' drawing and the crank put in position, but now a new difficulty arose: the crank struck the stuffing-box before it reached the end of its stroke, as shown in Fig. 4, and Jones was again called upon for advice.

"Well, you didn't bend it according to my sketch, that's all. Hold the crank so, with the short hub toward you and the top will point to the right and that curve will just clear the stuffing-box."

"Sketch shows the long hub toward you," said the workman.

"No, it don't; hold it so, and look at it; see?"

"Yes, I see, and leave it to anybody if that long hub ain't on the nigh side according to your draft."

Matters were becoming interesting; evidently the services of peace commissioners would soon be necessary. Now, in a country place all disputes are referred either to the minister or the schoolmaster, but it is doubtful if either would be qualified to act in the present case. However, Jones happened to think of his acquaintance with the bridge engineer, and it was at once agreed to accept his decision. He listened patiently to the evidence and smilingly declared it to be the old story of the red shield and the green shield, all depending upon how it was seen.

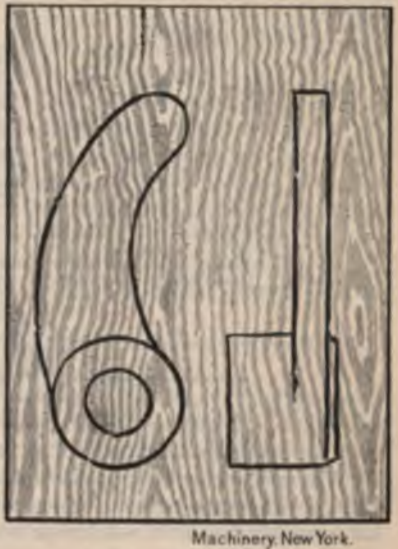


FIG 2. JONES' SKETCH.

"Mechanical drawings," he said, "are commonly made either in the first angle or the third angle of projection."

"Didn't make mine on any angle at all; made it on a curve, full size," interrupted Jones.

"How did you go to work to do it," asked the engineer.

"Laid the forging down on a board and marked 'round it for one view; then I tipped it over on edge and squinted and marked at it as well as I could."

"Exactly, Mr. Jones, and your method was perfectly correct. It was as if you bent a piece of paper and held it up behind the forging while you marked around it (Fig. 5) and afterwards smoothed the paper out like this" (Fig. 6).

"Yes," cried the delighted Jones, "that's jest what I did and I should think any numbskull might understand it."

"Softly, Mr. Jones; your method was correct; but 'there are others;' suppose now that your paper was transparent and was held in front of the forging like this (Fig. 7), and you saw through the paper just as you see through that window, and you traced the outline on the paper as you saw it; then the right-hand view will appear reversed as compared with the one which you made" (Fig. 8).

"Probably your blacksmith was used to this kind of a drawing while you had the other in mind. You were right in thinking that your way was right, but you were wrong in thinking that the other way was wrong. Both methods are right and both are in common use. Your way is known as the first angle, and the other was the third angle of projection."

FIG. 3. "AIN'T THAT HANDLE CURVED?"

"Thank ye, sir," said Jones; "much obleeged."

"Not at all, Mr. Jones; fact is, I was just thinking of coming over to your shop to see if I could borrow an expanding reamer."

"Expanding rimmer?"

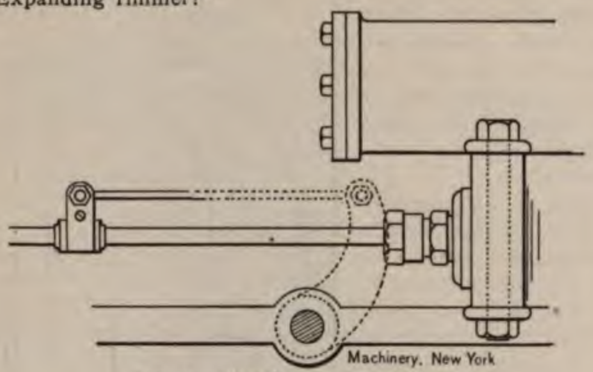


FIG. 4. JONES' SECOND MISTAKE.

"Yes, one of the kind that will fit different sizes of holes."

"Why yes, of course; guess my wife isn't using of it now." With which remark Jones disappeared into the house, leaving his astonished visitor wondering what kind of a wife or what sort of a reamer he had. He quickly reappeared with a stove rimmer! One of the kind where one size fits inside of another, thus providing different sizes of holes! The engineer turned away sadly, went home, and ordered a year's subscription of MACHINERY to be sent to the Jones Engineering Co.

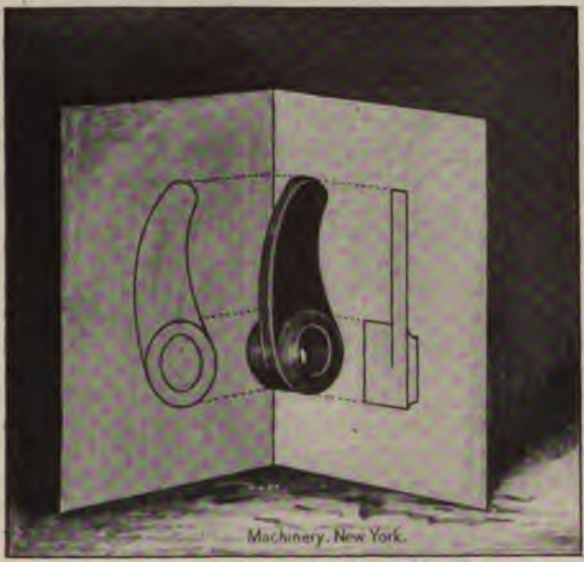

Machinery, New York.

FIG. 5. THE FIRST ANGLE OF PROJECTION.

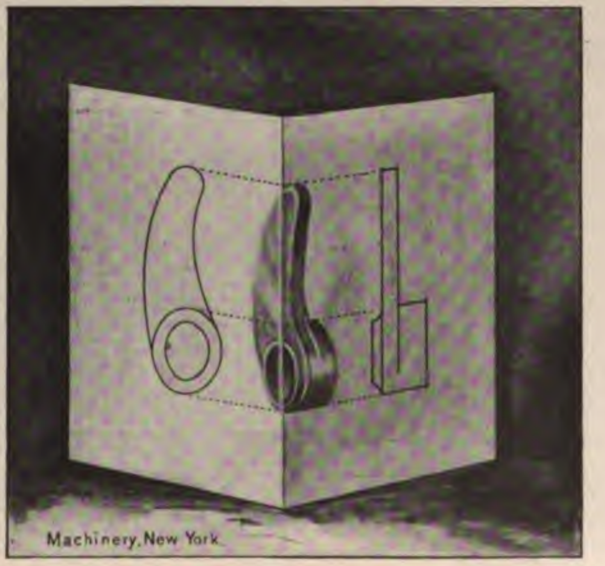


FIG. 7. THE THIRD ANGLE OF PROJECTION.

W. H. S.

## A SCHOOL OF ELECTRICITY.

The Educational Department of the Harlem Branch Young Men's Christian Association, at No. 5 West 125th street, has added to its curriculum a course in electricity. The aim is to make this course of practical value to all men who are interested in any branch of electrical work.

The school, which opened on October 17, is in charge of Mr. William J. Clarke, who is a thoroughly practical man from every standpoint, having seen active service in nearly every branch of electrical work.

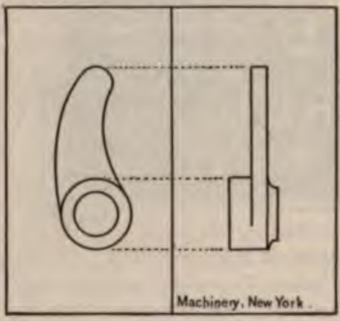


FIG. 6.

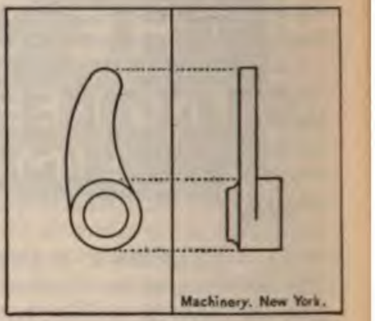


FIG. 8.

The sessions are held on Tuesday and Friday evenings, and the course will consist of forty-eight lectures. Mr. Clarke commenced by thoroughly grounding the class in the fundamental rules and principles of electrical engineering, and during the course he will cover fully the various branches of telegraphy, telephony, police and fire-alarm telegraph, arc lighting, alternating current apparatus, the distribution of electric power, the electric street railway, the electric automobile, the X-rays and wireless telegraphy.

Each lecture is illustrated by diagrams thrown upon the screen by means of a powerful stereopticon, so that each member of the class may readily follow the explanations of the teacher, and, in addition to this, a large amount of apparatus is used in illustrating the work. At the close of each lecture the members of the class will be permitted to ask questions, so that all may leave the class-room feeling that they have thoroughly mastered the particular subject under discussion during the evening.

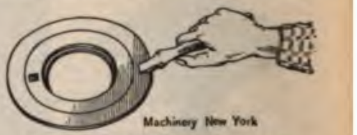


FIG. 9. AN "EXPANDING RIMMER."

The cost of the course is placed at the nominal fee of $10, including limited membership in the branch for one year, with its valuable privileges. Full particulars and application blanks may be secured by addressing the secretary.

* * *

## WORTH NOTING.

The "National Druggist" gives some interesting information respecting the fire-extinguishing qualities of aqua ammonia which are worthy of attention, as the following will indicate:

"In one instance, where fire had originated, probably from spontaneous combustion, in a pile containing several tons of cotton-seed, and the interior of which was almost a solid body of live coal, a half gallon of ammonia completely smothered the fire. In another, which occured in France, the vapors of a tank containing 50 gallons of gasoline caught fire in the linen room of a laundry. The room was instantly a mass of flames, but a gallon and a half of ammonia water thrown into it completely and almost immediately extinguished the fire. The ammonia was in a glass demijohn in an apothecary's shop next door to the laundry, and was thrown into the room by the druggist as an experiment. To use his own words in reporting the circumstance * * * 'The effect was instantaneous, torrents of black smoke rolled upward in place of flames, and in a moment every trace of fire was gone. So completely was the fire extinguished, that workmen were enabled to enter the room almost immediately, where they found the iron tank of gasoline intact.'"

* * *

Joseph Clement, born in 1779, is said to be the inventor of the thread tap having a shank small enough to allow the tap to drop through the threaded hole. One of his workmen was the afterwards famous Joseph Whitworth, the originator of the present English system of screw threads.

# GAS ENGINE DESIGN.—1.

## EXPLANATION OF GENERAL PRINCIPLES.

E. W. Roberts

Before taking up the design of any piece of machinery, it is imperative that the designer should understand as clearly as possible just what that particular piece of machinery is to do. In the design of an engine of any kind, it is equally as important that what takes place inside the cylinder should be well known. The designer will find it of great assistance to first lay out the indicator diagram that he expects the engine will give; this is particularly so in cases where entirely new features are to be introduced. If he understands clearly what the diagram indicates, he will have at hand the principle data upon which to base his calculations.

Before taking up the subject of gas engine design, it will be necessary to briefly consider the series of operations which take place in the cylinder of a gas engine. With the exception of the Diesel motor, all gas engines now being manufactured employ the Beau de Rochas cycle. The series of operations which comprise this cycle was first proposed by M. Beau de Rochas in 1870. It was not, however, put into practical form until it appeared in the first Otto engine in 1876. For this reason it is quite frequently called the Otto cycle, although the honor of its conception belongs unquestionably to Beau de Rochas. There is also in use a modification of this cycle in which a portion of the necessary operations are carried on in a separate device or its equivalent in order to permit the entire cycle to be completed during one revolution of the crank-shaft instead of two revolutions as required in the Beau de Rochas cycle.

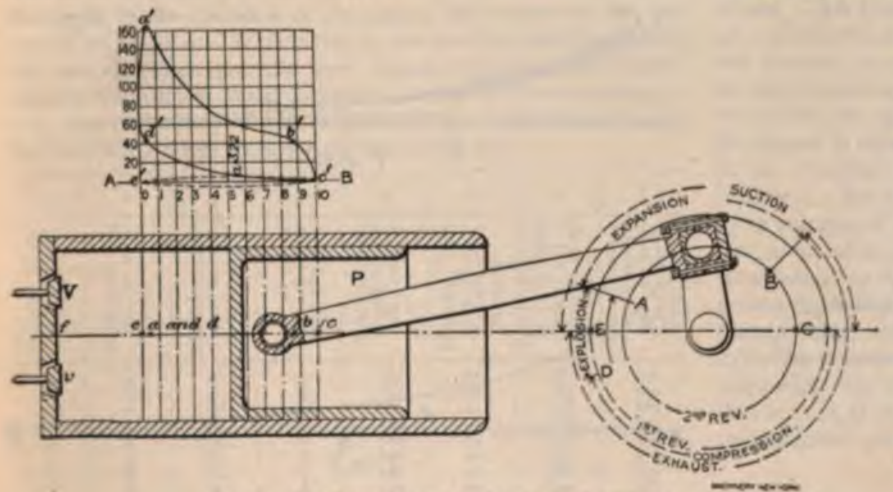


FIG. 1. SHOWING THE ACTION OF THE ENGINE.

The series of operations which take place during the four piston strokes necessary for the completion of the entire Beau de Rochas cycle is as follows: During the first forward stroke, gas and air are drawn into the cylinder and this mixture—called the charge—is compressed into a space at the end of the cylinder into which the piston does not enter. Just before the piston reaches the end of the compression stroke, or in some engines just as it reaches the end of the stroke, the charge is ignited. The ensuing explosion gives rise to a sudden elevation of pressure and temperature and during the next forward stroke the products of combustion expand. Just before the end of the expansion stroke, the exhaust valve is opened, permitting the contents of the cylinder to escape to the atmosphere. The following return stroke clears the cylinder of burnt gases, more or less thoroughly, according to the design of the engine.

The foregoing series of operations will be better understood by reference to Fig. 1, in which the indicator diagram given by the engine is placed immediately over the cylinder. For convenience of reference, the stroke of the engine is divided into ten equal parts, and lines are drawn from the cylinder to the diagram. Similar letters refer to the same point of the cycle and the letters are primed upon the diagram and capitalized upon the crank circle. The suction stroke starts at (e), the charge being drawn through the valve (v). Upon the return stroke, the admission valve (v) is closed and the charge is compressed into the space between the piston (P) when at the end of the return stroke and at the end of the cylinder; that is, into the compression space. The point of ignition is indicated upon the diagram at (d). As shown by the diagram, the pressure rises more rapidly at this point than during the early part of the compression stroke and at the end of the stroke the charge becomes fully inflamed, the pressure rising with great rapidity until the point of maximum pressure is reached, just before the piston starts on the expansion stroke (a), (b). The exhaust valve (V) opens just as the piston reaches (b), and from this point to the end of the stroke the pressure falls much faster than during true expansion. Upon the second return stroke, or while the piston is passing from (c) to (e), the products of combustion are driven from the cylinder.

The cycle is given in tabular form for easy reference:

1st Revolution:—Forward stroke; suction. Return stroke; compression, ignition, explosion.

2nd Revolution:—Forward stroke; expansion or power stroke (release). Return stroke; exhaust stroke.

The indicator diagram which is given in Fig. 1 is shown on a larger scale in Fig. 2. To have his engine produce such a diagram, should be the goal of every gas engine designer. There appears to be no reason why such a goal may not be reached by everyone, since the diagram is an enlargement of one actually taken from an engine operating on the Beau de Rochas cycle. In the writer's experience, the most successful engines on the market today are giving just such diagrams.

The notable points about the diagram shown in Fig. 2 are as follows:—The compression curve is smooth and is a regular curve from the beginning of the compression stroke to the point of ignition. The gas, ignited at (i), is fired just early enough to bring the point of maximum pressure at the beginning of the forward stroke, and the line (ab) indicating the rise of pressure lies at right angles to the atmospheric line (x), (y). The expansion line is smooth and does not show a series of steps as the pressure decreases. The release or point at which the exhaust valve opens is at (c), and it occurs at the proper moment to bring the point (d), where the expansion line meets the atmospheric line, directly at the end of the stroke. Wire-drawing on the suction and on the exhaust strokes, would be indicated by lines similar to (xsy). The writer is aware that there is some difference of opinion regarding what constitutes an ideal gas engine diagram. This is especially true with reference to the point of stroke where ignition should take place. The majority are in favor of such a diagram as is recommended.

The diagram shown in Fig. 3 is a puzzling one. The wavy appearance of the expansion line is produced, not by conditions within the engine itself, but by the vibration of the indicator spring. A somewhat similar diagram might be expected from a badly mixed charge in which case the rising side of the wave would be much steeper than the falling side.

Fig. 4 is reproduced from an actual diagram and shows the effect of late ignition, which takes place at (i) after the piston has started on the power stroke. The amount of work which is lost because of the delayed firing is indicated by the area enclosed within the dotted line at the left of the diagram proper. No better argument for early ignition could be given.

The effect which is produced by too early ignition is shown in Fig. 5. This is a diagram very seldom obtained because the defect is readily shown by the action of the engine and is easy to remedy. The point of ignition is at (i) and the loss of work is shown by dotted lines as in Fig. 4.

A study of the cooling effect of the water jacket may be made when the engine is running by taking cards when the igniter is shut off. Examples of such diagrams are given in Figs. 6 and 7. In Fig. 6 the compression and expansion lines are quite distinct from each other at the left end of the card showing that the cylinder walls are sufficiently warm to heat the air and raise the pressure of the cylinder contents, before the expansion stroke has begun. In Fig. 7 the compression and expansion lines are identical. In the writer's judgment, this proves that the cylinder walls are too cold for the best economy, an unnecessary amount of heat being carried off by means of the jacket water. In Fig.

7 will be seen the effect produced by constricted exhaust and air passages. The line (xey) indicates wire-drawing of the exhaust and the line (xsy) wire-drawing of the entering charge.

The effect upon the indicator diagram produced by late release, is shown in Fig. 8. The exhaust valve opens at (e) and the line of the diagram does not reach the atmospheric line (x y) until the piston has returned to (f), thus giving an unnecessary back pressure at the beginning of the exhaust stroke.

Figs. 3 to 6 inclusive teach an excellent lesson in what to avoid when designing a gas engine. The inlet and the exhaust ports, also the corresponding valves and passages, should be made of sufficient cross-section to avoid appreciable wire-drawing. Ignition should take place at such a point as to give maximum pressure at the beginning of the power stroke. In this connection it may be said that the best way to set an igniter is by means of the indicator. The exhaust valve should always open in time to produce a meeting of the expansion line with the atmospheric line just at the conclusion of the power stroke. The jacket water should be so controlled that an unnecessary amount of heat may not be carried away through the walls of the cylinder. It will be the writer's endeavor, as this series of articles progresses, to point out the best methods of accomplishing these results.

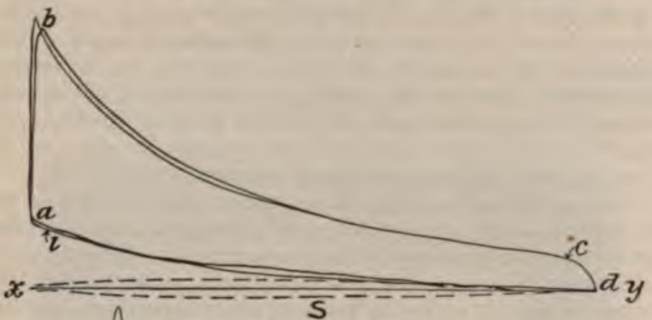


FIG.2

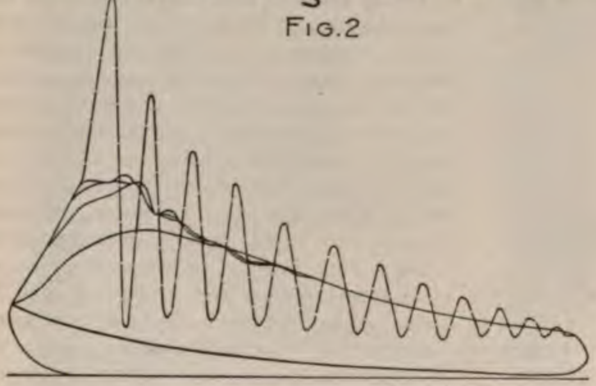


FIG.3

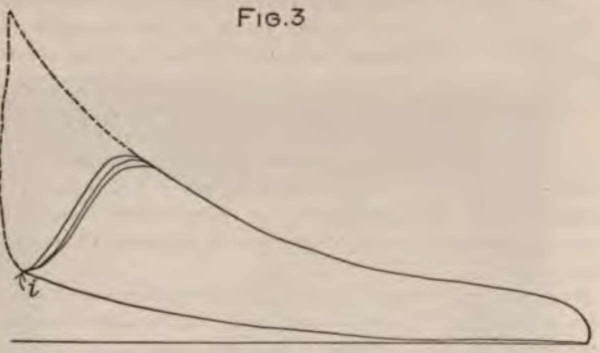


FIG.4

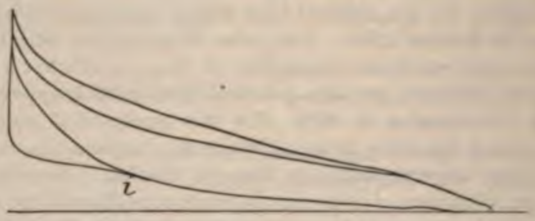


FIG.5

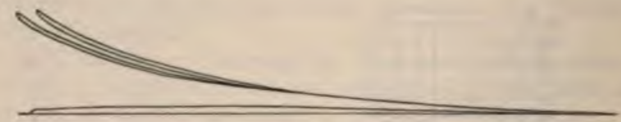


FIG.6

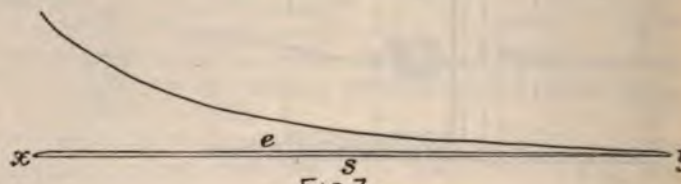


FIG.7

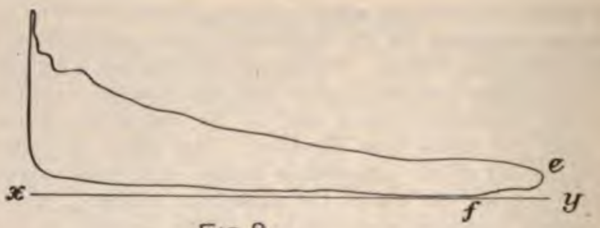


FIG.8

GAS ENGINE CARDS.

When the mixture of gas and air is exploded at atmospheric pressure the resultant action of the gases depends upon two conditions, one of which is the quality of the combustible gas and the other, the proportionate amount of this gas to the air contained in the charge. A series of experiments made by Mr. Dugald Clerk, the well known English gas-engine expert, gave results which show the action of these mixtures. Mr. Clerk employed for his experiments the apparatus illustrated in Fig. 9. A chamber E, 7 inches in diameter by 8½ inches high, contains the mixture to be tested. A steam-engine indicator I, was attached to the explosion chamber E and the drum of the indicator was operated by clock-work as shown. The power to run the clock train was supplied by the weight W and the speed regulated by the fan (F). By means of this arrangement, the pressure exerted in the chamber (E) was transmitted to the piston of the indicator, which in its turn raised the pencil (q). In the conduct of the experiments a carefully measured and proportioned mixture of gas and air was drawn into the chamber (E) and the gases fired by means of an electric spark. The drum having already been set in motion, the pressure of the gas exerted on the indicator piston, compressed the springs raising the pencil (q). The pencil left a record upon the drum in the form of a curve somewhat similar to the upper portion of the ordinary gas engine diagram; vertical distances, measured on the line (xy) representing pressures and horizontal distances measured on the circumference of the drum representing intervals of time.

With this piece of apparatus the successive alterations of pressure, from the time the gas was ignited until it had reached a pressure closely approaching that of the atmosphere, were determined. Nine of the curves thus obtained are shown in Fig. 10 and they illustrate the action of one variety of gas when mixed with air in various proportions. The different curves may easily be distinguished by the aid of the letters a, b, c, etc., which are placed at each end of the diagram.

| Curve | a | b | c | d | e | f | g | h | i |
|---|---|---|---|---|---|---|---|---|---|
| Volumes of air to one of gas | 14 | 13 | 12 | 11 | 9 | 7 | 6 | 5 | 4 |

In this figure, only that variation of pressure which takes place during the first second is shown. The line (x y) is divided into twenty equal parts, each one of which represents a lapse of .05 second The distance between each horizontal line represents a difference of pressure of five pounds. The time is measured from the moment when ignition takes place as indicated by the rise of pressure.

A careful study of the curves will show that when the mixture is weak in gas, the rise of pressure is very low, the time between ignition and the moment when the gases reach their maximum pressure being nearly .45 seconds for curve (a) and but .04 seconds for curve (g). This lapse of time indicates very closely the fraction of a second it takes for the gas to become one entire mass of flame, or to express it differently, the time required for full inflammation. The rate at which the pressure rises after ignition is indicated by the inclination of the curve. This inclination is of course very steep when inflammation is most rapid, and the inclination decreases as the rate of inflammation is lowered, the curve becoming more nearly parallel to the lines (xy). The rate of fall of pressure is indicated by the inclination of the line beginning at the point of maximum pressure and continuing to the right of the figure. This rate of fall is not shown as far as the point where the pressure of the mixture reaches that of the atmosphere. It may be stated that this point was reached approximately 1.88 seconds after the time when the ignition took place.

It must not be thought that when the mixture is totally inflamed the gas has been entirely consumed. A peculiarity of such mixtures as this is that at the high temperatures produced in the gas engine a certain proportion of the gas remains uncombined with air and is not burned until a lower temperature has been reached. The effect of this phenomenon, called dissociation, is that heat is constantly being added to the mixture by this late combustion, keeping the pressures upon the expansion line much higher than could be obtained without it, under the conditions which are present in the cylinder. This phenomena is no detriment to the operation of the engine but is rather in the nature of an assistant. It must not be thought that the mixtures of gas and air which give the most violent explosions and consequently the highest initial pressures are the most economical to use. An illustration of this is given in the table shown below, the data being taken from the curves in Fig. 10:

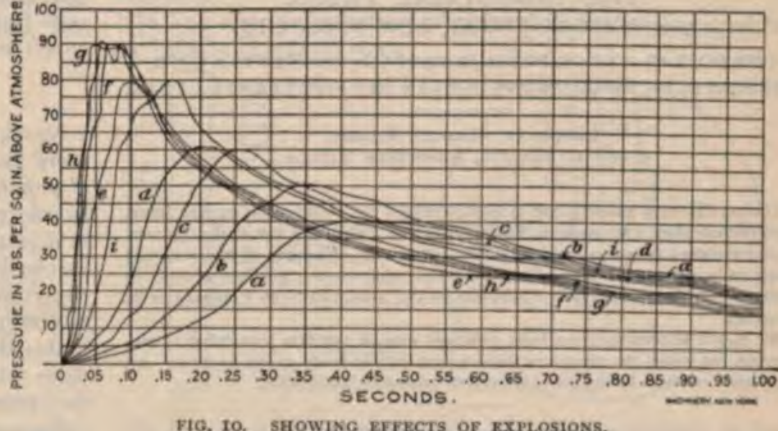


FIG. 10. SHOWING EFFECTS OF EXPLOSIONS.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| Volumes of air to 1 volume gas. | Proportion of gas in mixture. | Maximum pressure in lbs. per sq. in. | Area of piston to each cubic inch of gas. | Total maximum pressure per cubic inch of gas. | Pressure per square inch .2 seconds after maxmum. | Total pressure to each cubic inch of gas .2 seconds after maximum. | Mean pressure on piston for first .2 sec. after maximum. |
| 14 | 1/15 | 40 | 15 | 600 | 31 | 465 | 532 |
| 13 | 1/14 | 51.5 | 14 | 721 | 40 | 560 | 640 |
| 12 | 1/13 | 60 | 13 | 780 | 42 | 546 | 663 |
| 11 | 1/12 | 61 | 12 | 732 | 44 | 528 | 630 |
| 9 | 1/10 | 78 | 10 | 780 | 44 | 440 | 610 |
| 7 | 1/8 | 87 | 8 | 696 | 47 | 376 | 536 |
| 6 | 1/7 | 90 | 7 | 630 | 52 | 364 | 497 |
| 5 | 1/6 | 91 | 6 | 546 | 50 | 300 | 423 |
| 4 | 1/5 | 80 | 5 | 400 | 46 | 230 | 315 |

Although the above table shows what would take place in an engine having no compression, and which draws the charge in for about half the stroke and then ignites it, it is of assistance to the designer in judging of the action of gases and in choosing the best mixture for a given engine. That proportion of gas to air, which gives the highest pressures for the quantity of gas used, is undoubtedly the best. For instance, let the distance between the end of the cylinder and the piston be exactly one inch; then there will be one square inch on the surface of the piston for every cubic inch contained in the above space. In order to calculate the highest pressure which will be given with a certain quantity of gas proceed as follows: If the mixture contain one volume of gas to seven of air, there will be eight cubic inches of the mixture for each cubic inch of gas, and in a layer one inch deep the surface of the layer will be eight square inches. Since in the preceding table the maximum pressure for a mixture of the above proportion is 87 lb. per sq. in., the total pressure exerted by each cu. in. of gas is 87 x 8 = 696 lb.

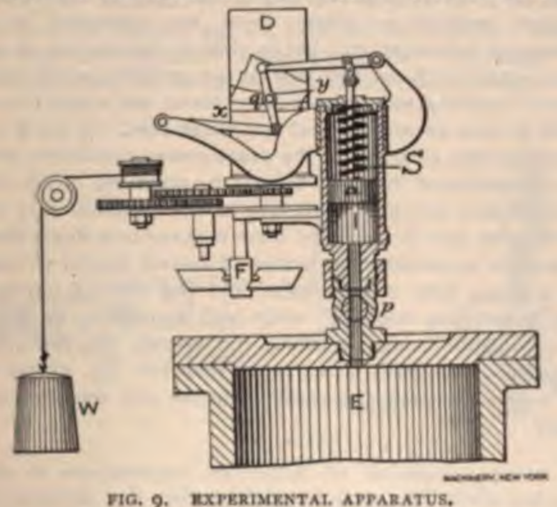


FIG. 9. EXPERIMENTAL APPARATUS.

That mixture which gives the best mean pressure for the first .2 sec. is that which gives 663 lb. mean pressure to each cu. in. of gas. This mixture is that containing 1 volume of gas to 12 of air. Could the power stroke be considered as taking place without increase of volume, the pressure given in column 7 would be that remaining at the end of .2 sec. and that given in column 8 would be the mean pressure for the same length of time. Thus the figures in column 8 give a means of comparison of the powers to be obtained with the corresponding mixtures indicated in column 1. For instance, that mixture having one volume of gas to 13 volumes of air has more than double the power of the mixture containing one volume of gas to four volumes of air, the ratio being 640 to 315, the power considered being that available during the first .2 sec. after maximum pressure. Do not imagine that an engine could operate without increasing the volume of the cylinder; this assumption is taken as a convenient means of comparing the values of the various mixtures. It is important that in each of the above cases the gas be considered as if it gave its maximum pressure at the beginning of the stroke.

* * *

## SPECIFICATIONS FOR PUMPS.

Philip R. Bjorling, a Swedish engineer, who has become an authority on pumping machinery among English engineers, gives, in a recent number of "Feilden's Magazine," the following specifications, which he considers to be essential to a perfect pump:

"All valves and ports should be arranged so as to obviate the possibility of air lodging at any part, the air always rising to the highest point.

"The various sections of the pump should always have, as near as possible, the same area, for the reason that when the area increases or decreases the speed of the water is likewise affected; consequently, a shock occurs when currents of different speeds meet. This cannot conveniently be carried out with horizontal pumps, but the ports and passages should be kept of the same area as that of the suction or inlet pipe.

"All bends should have an easy curve, and all sharp corners should be avoided; all passages should be made round, when possible, because they create less friction and are stronger.

"The under-side of the delivery valve-seat should be level with, or above, the top of the pump barrel.

"The valve should never be allowed to meet a flat surface.

"The ram or plunger should not be flat at the end, as is the usual way adopted in England and America, but made in the shape of a parabola or an ellipse.

"Open-ended rams should always be avoided, because they increase the clearance space as much as the capacity of the interior of the plunger."

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## NOVEMBER, 1899.

### CIRCULATION STATEMENT.

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The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

| | |
|---|---|
| The IRON AGE, about | 7,000 |
| The AMERICAN MACHINIST, about | 12,000 |
| MACHINERY | 17,750 |

### THE INFLUENCE OF A FOREMAN.

A machine shop is a commercial enterprise which is supposed to be carried on primarily for the interests of the owners. To conduct the various operations incident to the manufacture of machinery and tools, it is necessary to have other machinery and tools for their production. It is also necessary to employ men to operate these machines and tools, and foremen are required to supervise the efforts of the men and to direct their efforts in the interests of the greatest production for the least expense.

The characteristics of the foreman are often overlooked by machine shop proprietors. When he is hired the only inquiry is likely to be as to his executive qualities and his ability to produce economically. While a machine shop is not supposed to be a goody-goody sort of a place, the character of the men employed has a wonderful effect on the quality of the product and the general reputation of the shop. A machinist who is honest cannot scamp work intentionally nor hide work that has been accidentally spoiled, as his conscientious scruples will not allow him to do so; but if his instincts be dishonest or if the foreman's influence be bad from an ethical point of view, the general moral tone of the shop will be lowered and the honesty of purpose and effort that are always required to produce the best products will be wanting. We believe that no machine shop proprietor can afford on general principles to employ foremen who are known to be dishonest, immoral or of drunken habits, as the influence on the men in their charge will invariably be to lower the general status of the shop.

The power of influence is too great to be disregarded, and, as can be attested to by any one familiar with machine shop practice, the general characteristics of the foreman are more or less reflected on the men who look to him for orders. We believe that a foreman for a shop should have for recommendations, aside from his ability as a machinist, honesty of purpose, a clean mouth and a temperate mode of life.

* * *

### THE COST OF THE COAL PILE.

About two years ago a committee was appointed by the Engineers' Society of Western Pennsylvania to investigate the cost of power, not as determined by expert test simply, but as shown by every-day commercial results, under various conditions and in different plants. The work of the committee was not entirely successful, because, as their inquiries demonstrated, comparatively few power users know, even with an approximate degree of certainty, how much their power is costing them. That there is this lack of definite knowledge is certainly not creditable to those who are supposed to have the economical production of the products of these establishments in their care.

The committee show very clearly how the fuel burned under a boiler during the lifetime of that boiler will make the first cost of the plant look very diminutive, by the following argument, based on the cost of coal at Pittsburg, which is probably the cheapest coal market in the world.

"Assume that one H. P. boiler capacity is the ability to evaporate 30 pounds feed water per hour. Assume an average ratio of coal to water as being 1-9. Such a boiler will require $30/9 = 3\ 1\text{-}3$ pounds coal per H. P. per hour, and in one day of 24 hours $24 \times 3\ 1\text{-}3 = 80$ pounds of best quality coal will be consumed per H. P. In 300 days the amount of coal thus burned reaches the very considerable total of 24,000 pounds, or 12 net tons. The best quality of coal will be required to give such a performance, and the coal will cost the average consumer nearly, if not quite, $1 per ton in Pittsburg. The annual cost of fuel then will be $12 per H. P., and this is much more than the first cost of some types of boilers, and is almost equal to the price asked for the very best. The lifetime of a good boiler ought not to be less than 15 or 20 years, and during such a life our aforesaid boiler may have consumed for each H. P. in capacity, fuel worth from $180 to $240, and even more. Such figures do not overstate the case—indeed they are entirely too low as compared with the actual results of ordinarily good plants, and it is not impossible that the results thus indicated may be 50 per cent. too good for a great deal of practice. If this be so, then a 20-year boiler may have to answer for the disappearance of, say, $360 per each H. P. of its capacity, or for a 100 H. P. boiler, the enormous sum of $36,000 "gone up in smoke." Of course such a boiler is "laid up" for part of its time, and may not be fired to capacity for 300 days per year, but in such case it is earning less, and the validity of the argument is not affected. Is such a sum worthy of scrutiny, and is the subject fairly comprehended by those whose duty it is to take care of such matters?"

There are difficulties in the way of determining the economy of a plant, particularly where there are numerous pumps, small engines, hammers, etc., but in view of the expense of operating compared with the first cost, it is a problem worth attacking, even if nothing more than a water meter and a pair of scales are used to keep records of coal and water used. In many cases it is not possible to arrive at the exact power consumed, owing to the fluctuation of the load, but the frequent use of the steam engine indicator will give some clue to the question. The committee suggest that in any plant there is scarcely a single feature that excels in importance the matter of correct size of an engine to do a given duty economically, and the idea of having an engine "plenty big enough," while well enough in its way, is easily capable of being overdone. Of course, the converse is also true and too small is no better than too big, except that errors in this direction are usually detected and corrected more promptly.

* * *

The recent shipment of American locomotives to Great Britain has elicited the consoling information (for Britains) that as far back as 1840 five locomotives were shipped from New York to England for use on the Gloucester and Birmingham Railway, and that, while the American of that day foresaw that the iron industries of Great Britain were to be injured by competition with the United States, the prediction was not realized, and is no more likely to be at the present time.

# MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—4.

## DRIVING LATHE WORK.

W. H. Van Dervoort.

The dog or driver connects the work with the spindle of the lathe, and in its common form is shown in Fig. 23. For all ordinary work this device serves its purpose well; for very accurate work, however, the effect of its leverage must be taken into consideration. As shown at A in the figure, the distance between the dotted lines represents the lever-arm, which acts on the center as a fulcrum, and produces or tends to produce a deflection in the work. Again, the force being applied at D, and the pressure of the cut at C, the tendency to bend the work will be greater than when the point D has moved round 180 degrees, or on the same side as the tool. The first of these objections is overcome by using the straight-tail dog, as shown in Fig. 24, with a stud or driver bolted on the face plate, and the second, by using a double-ended dog and driving from opposite sides, as shown in Fig. 25. The use of the double-ended dog is usually not altogether satisfactory, as it is very difficult to so adjust the drivers that the pressure against each will be uniform. Double-ended dogs are frequently made adjustable. The usual way, however, is to adjust the driver pins rather than the dog.

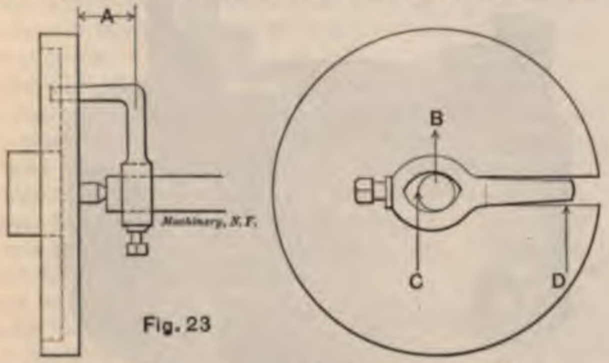


Fig. 23

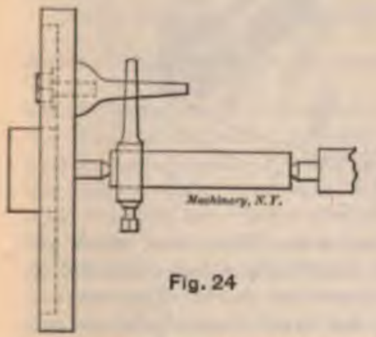


Fig. 24

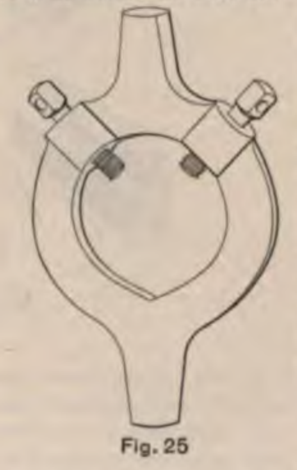


Fig. 25

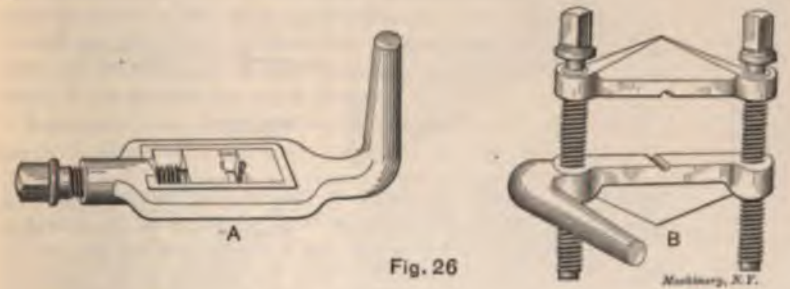


Fig. 26

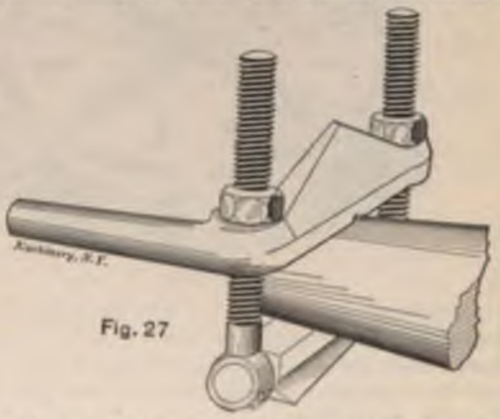


Fig. 27

As the dogs above shown depend on a screw to hold them securely on the work, care must be exercised or the work is very apt to be injured. The screw should always have a hardened, flat or oval point. While such a point does not hold as firmly as the cupped point, it does not cut into the work as badly. When used on finished work a ferrule of sheet brass, or, preferably, copper should be put on the work under the dog to prevent any injury to the work surface. The screw should be tightened enough to safely drive without slipping. If the dog slips it is quite certain to injure the surface.

For many cases, and more especially on finished work, the die and clamp dogs, shown at A and B respectively, Fig. 26, are excellent. These dogs are very nicely made of forged steel and hardened.

In Fig. 27 is shown a form of clamp dog very well adapted to the holding of tapered work.

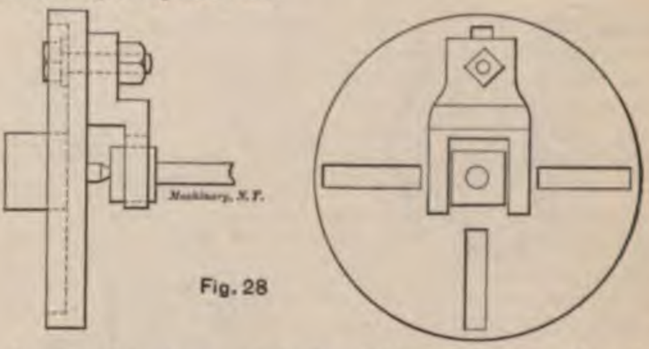


Fig. 28

In Fig. 28 is shown a bolt dog. This tool is clamped to the face-plate so as to receive the head of the bolt. It will drive square or hexagon head bolts, and, where a number are to be operated upon, will save the time that would be required to put on and take off the common dog.

When a dog must be used on the threaded end of a bolt or spindle it is necessary to protect the thread, or it will be injured by the dog screw. If the work to be driven does not require the screw to be tightened very hard, a heavy piece of brass over the thread will usually be found satisfactory. A common practice in cases of this kind is to jamb two nuts on the thread and place the dog on the outer nut. In Fig. 29 is shown a very satisfactory form of dog for use in such cases. It should be made of forged steel, tapped the required thread, and split as shown. The clamp screw locks it securely on the thread.

Very light work is frequently driven from the center without the use of a dog, thus enabling the work to be machined all over without changing ends. When an exact center is not required in the finished work the square center may be used to drive it. Instead of making a round center bearing on the live center end of the work, a pyramidal or square center is formed with a punch. This bearing fits over a square live center, which drives the work. A square center is a difficult one to keep in proper shape.

Another method of driving light work from the center consists in milling a thumb-nail notch in the live center end of the work, as shown at A in Fig. 30, and using a live center with a driver, as shown in Fig. 31. In this case true round centers are used.

A great deal of work done between centers does not require a dog, as a face-plate stud or driver will engage some part of the work, as shown, for example, in the case of a pulley in Fig. 32. The driver in such cases should be placed as far from the center as possible, thus making it firmer and steadier. The face-plate driver should be a stiff, substantial one. A bolt strung full of nuts and washers will answer after a fashion, but the one shown at A of steel, or at B of cast iron, in Fig. 33, will be found much more satisfactory. Two or three lengths will usually meet all requirements. Lathes are usually provided with two face-plates, one of large diameter and one of small. The small plate is the one usually used for driving the dog on work held between centers. It is generally a round plate, with one or four notches. The plate shown in Fig. 34 is sometimes used, but for reasons of safety is not as good as the round one. At least one notch in each plate should extend well down to the center, thus enabling the use of the smaller dogs when operating on light work.

Lathe work not held between centers can be classified under the heads of center rest, carriage, face-plate and chuck work, the distinction between the two last classes being narrow. Center-rest work includes all in which the center-rest carries one end of the work and the live spindle the other. Carriage work includes such classes as are operated upon by a rotating cutter while screwed to the carriage of the lathe. Chuck and face-plate work covers that wide range of operations upon work rigidly screwed on the live spindle.

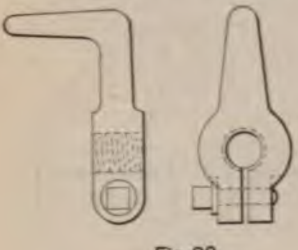


Fig.29

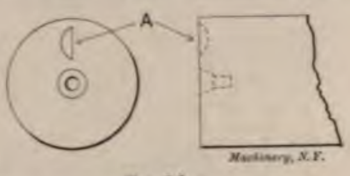


Fig.30

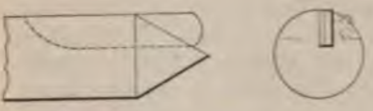


Fig.31

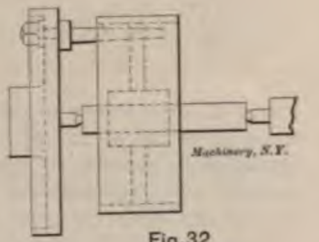


Fig.32

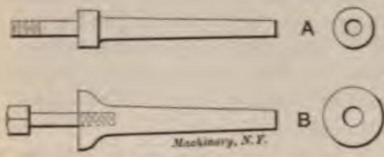


Fig.33

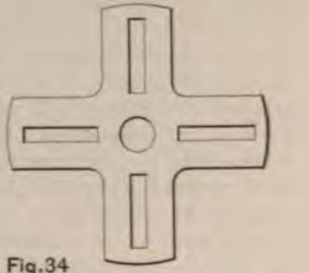


Fig.34

The lathe chuck is a device for holding the work more firmly and adjusting it more accurately than is possible when clamped or bolted to the face-plate. Chucks are classified as independent, universal and combination. In Fig. 35 is shown an independent four-jawed lathe chuck. These chucks are made with two, three or four jaws fitted accurately in radial ways in a substantial plate or body. Each jaw is operated independently by a square thread screw. The jaws may, in order best to conform to the character of the work, be reversed.

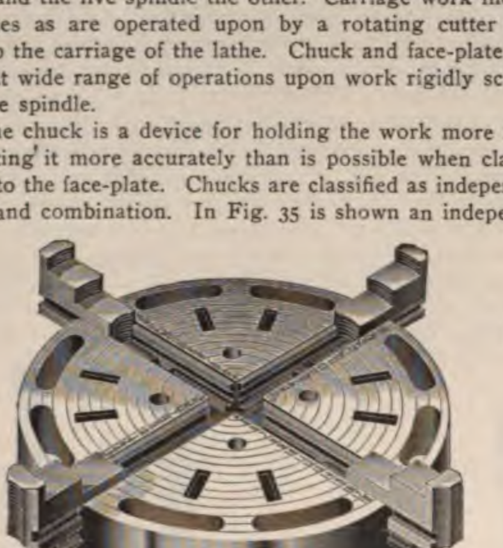


FIG. 35.

The universal chuck, an example of which is shown in Fig. 36, is usually a three-jawed chuck, although they may be had with four jaws. In this chuck the jaws all move together. The universal chuck is used mostly on milling and grinding machine heads, screw machines, cutting-off machines and other places where it is desired to quickly center lathe work. When new, first-class universal chucks center work very accurately. After they become somewhat worn they should not be relied upon for exact centering.

The combination chuck involves both the independent and the universal characteristics, as by a slight adjustment it may be quickly changed from the one to the other. In many places this chuck is very nicely adapted, but for general, every-day lathe work the independent four-jawed chuck is more suitable.

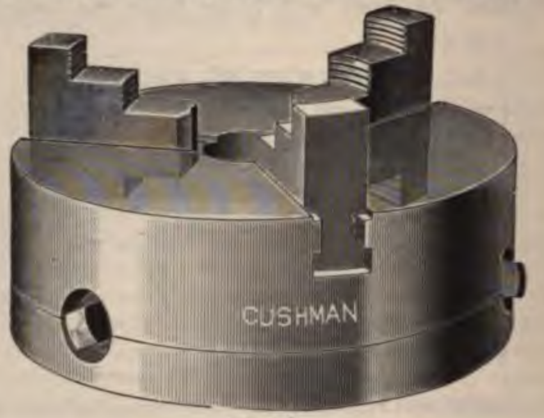


FIG. 36.

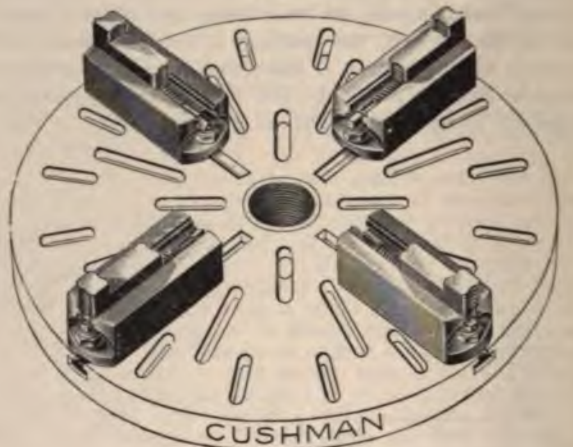


FIG 37.

In Fig. 37 are shown face-plate jaws. These jaws, which are perfectly self-contained, may be attached to a face-plate, and as such constitute a first-class independent chuck. They make a very satisfactory substitute for the larger sizes of chucks, and are frequently applied to very large face-plates.

It is frequently desirable to run a rough or curved hole on the dead center. This would quickly cut the center and ruin it for accurate work until reground. The hole in work of that character is usually too large to run on the regular center, if such were desirable, and either a large center must be provided to carry it or the hole plugged and a center bearing put in the plug. If the hole is concentric with the surface to be machined the large center is the cheapest and most convenient method. It is, of course, not adapted to the most accurate work, but for ordinary operations serves its purpose well. As it is necessary for the center to revolve with the work, to prevent its being cut, a special device is required. In Fig. 38 is shown such a center, commonly known as a pipe center. The construction is evident, the cone revolves on a stud and backs against a collar having ample bearing surface to take the thrust; it is also provided with suitable channels for its proper lubrication.

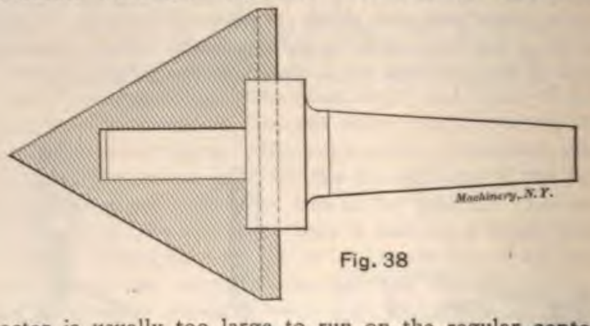


Fig. 38

## FAMILIAR SUBJECTS IN MECHANICS.—6.

### TRANSMISSION OF POWER BY GEARING.

SAMUEL WEBBER.

I have endeavored, in a short series of letters, to discuss in a simple way the transmission of power by shafts, belts and pulleys, and give such useful hints as a long experience had led me to think might be useful to young mechanics; but I have said nothing about one mode of transmission, which, in a historical sense, should have preceded both belts and ropes in the conveyance of large quantities of energy, or power, and that is the use of gears.

The methods used for this transmission of energy may perhaps be classed in four groups, as follows: For short distances, without possible loss of velocity, gears; for moderate distances in parallel planes, belts; for longer distances, when the weight of a leather belt is an objection, or when the shafts are not parallel, ropes; and for extreme distances, when these well-known and simple mechanical methods are impracticable, electricity.

On the latter subject I do not propose to touch, leaving that to some of the younger men who are handling the subject practically to-day, but I will go back to the earlier method of gears and endeavor to show the philosophy of some of the changes which are generally taking place in their use and construction.

"To begin at the beginning," as the boys say, the action of a gear tooth is that of a simple lever, and the common picture of "Archimides moving the world," as shown on the seal of the A. S. M. E., is a complete illustration of the action of a gear tooth. In the first place, we have to consider the strength of the tooth, which depends on the material used, and as this is most commonly "cast iron," we will take that for a starting-point, basing our calculations on the known strength of this material, as derived from numerous observations, under the law given and accepted for the strength of a beam fixed at one end to which strain is applied at the other.

This is the square of the depth, multiplied by the width, and divided by the length, or, as commonly expressed, $\frac{d^2 w}{l}$. Now, the old experiments of Boulton and Watt on English iron gave the breaking strain of a one-inch cube of cast iron in this position as 7,200 pounds. Of this he allowed one-third, as reaching the "elastic limit," and then divided that by five (5), making what is known as a "factor of safety" of fifteen, or 1-15 the breaking strain, as the safe load which might be applied to the point of a tooth, or 480 pounds. "Trials of American Iron," by Mr. Thos. B. West, published in the "American Machinist," gave an average breaking strain of over 8,000 pounds, so that I think it safe to assume a breaking strain of 7,500 pounds, and, following Watt's rule, I get 500 pounds per cubic inch as the safe load for a cast iron gear tooth.

It must also be remembered that the strength of a gear-tooth does not require this assumed thickness of one inch to be carried out to the point of the tooth, but that it may be cut away on the under side in a parabolic form and still be equally strong, and if, as is usually the case with an involute tooth, the amount cut off from the point of the tooth by the curve is added by the reverse curve to the base, where the strain theoretically comes, it will be seen that a tooth of the initial thickness at the pitch line will be in excess of any required strength derived from the basis of 500 pounds per cubic inch.

For many years, in calculating the necessary thickness of gear-teeth, I followed a formula given me by the late James B. Francis, well known as a cautious and conservative engineer, and whose practice was always considered "to be on the safe side." Here is the formula: "Thickness of tooth to be equal to $\sqrt[2]{\text{pressure}}$ in pounds × .020; but in 1879, twenty years ago, my attention was attracted to a paper published in the Journal of the Franklin Institute by my old friend, the late John H. Cooper, in which he gave a collection of the various formulae for the strength and dimensions of gear-teeth from the days of Boulton & Watt, and Tredgold, down to Nystrom and Jones & Laughlin.

He calculated from these different formulae the horse-power which might be safely relied upon from a gear of 3 inches pitch, 1.38 in thickness of tooth, and 7½ inches faces, 5 feet in diameter, at 60 R. P. M. These results varied from 47.06 HP. by Carmichael (1814) and 66.17 HP., Boulton & Watt, to 147.27 HP. Jones & Laughlin, 163 HP. Haswell, and 295.59 HP. (for two teeth in contact), Nystrom, the latter agreeing closely with Jones & Laughlin.

I will not quote these various formulae, as they would occupy space unnecessarily, but they set me to looking into the matter and endeavoring to prepare a formula for my own use which might be relied upon, starting on the basis already known, of 7,500 pounds breaking weight, and 1-15th of that, or 500 pounds per cubic inch as a safe strain.

Now, I found many of these older rules were based on the supposition that the gears might be thrown out of proper mesh, so as to bring all the strain on one corner of one tooth; these I rejected entirely, as I considered that gears should be so supported and braced as to render such a strain impossible. Next I found many of them were calculated on the basis of a much longer tooth than is now generally used.

The earlier rules gave the length of tooth as ¾, or .75 of the pitch. The rule given me by Prof. Willis, of Cambridge, England, at that time the great authority on those questions, in 1851, gave the length as 70 per cent. of the pitch, of which 30 per cent. was above and 40 per cent. below the pitch line, leaving 10 per cent. for clearance when the gears were in mesh. He gave the thickness of the tooth at pitch line as 5-11th of the pitch, and the space between teeth on same line as 6-11ths. The Lowell Machine Shop tables, many years since, gave the last two dimensions as 29-64ths and 35-64ths, respectively, and these rules were generally approximately followed.

Now, these old rules were all based on cast gears, liable to shrink more or less irregularly in cooling, as in the case of large gears moulded from wooden patterns, which warped and shrunk more or less when not in use, and required a longer tooth and wider clearance spaces than are now needed for accurately cut gears with more perfect methods of construction.

It is now perfectly safe to reduce the total length of tooth to 6-10ths of the pitch, even for large gears, and for machine uses to 5-10ths, and also to reduce the clearance from 1-10th to 1-20th of the pitch. By so reducing the factor of leverage, we get a much stronger tooth, in which the thickness is nearly equal to the length, and is, in fact, fully so at the base, if an involute is used.

If we then adopt the standard formula for beams, supported at one end as stated previously, we have for the strength of the tooth $500 \frac{t^2 f}{l}$ (1) and as we have reduced l to very nearly the same dimension as t, or 5-10 P, as against 5-11 P, and so strengthened t at the base as to lift the weakest point up to not over 4-10ths from the tip, we may discard l, by calling it equal to t, and make the formula 500 f t (2).

Next, if, as usual, $F = 2.5$ p, and $t = 5.11$ P, and the multiplication made, it will result in $S = 5.50\, t^2$(3).

Now, a horse-power is 550 foot pounds per second, and we therefore multiply the above by the velocity in feet per second, and divide by 550 to obtain the HP, which gives us HP = $\frac{500 \times 5.50\, t^2}{550}$ (4) or $5t^2 v$ in seconds (5), or, as velocity is usually counted in feet per minute = $\frac{t^2 v}{12}$ (6), and this applied to Mr. Cooper's data, gives 149.57 H. P., as against 147.27 from Jones & Laughlin, or for which Nystrom's data for two teeth is just double.

I believe I wrote out this matter partially for MACHINERY some years ago, but as the paper has now many more readers it seems well to include it with the other notes on shafts, pulleys and belts as a summary of practical hints on "Modes of Power Transmission." I may also refer to various letters from Mr. W. H. Booth in the columns of MACHINERY and the "American Machinist," to show that this shortening of gear-teeth is attracting attention in Europe as well as the United States. There may be cases, such as those of very small pinions, of from 12 to 16 teeth, where the reduction of the length to half the pitch is impracticable, as it will not give a second tooth a chance to get hold before the first one lets go, but these are rare, and in machinery generally two if not three teeth are in bearing at once.

Many of the old formulae are still to be found in various "Engineer's Pocket Books," and if any one has a desire to see Mr. Cooper's collection of them he will find them in the "Journal of the Franklin Institute" for July, 1879. Mr. Wilfred Lewis published a paper on the strength of gear teeth within a year or two, in which he reduces the useful effect to be derived from a gear tooth very much as its velocity increases, but I fail to see the propriety of such reduction unless in exceptional case of "back lash" or sudden reversal of direction of the power.

The strength of iron is certainly the same at whatever velocity it may move, and if not giving a blow like a hammer the strength should not be affected, as in a train of gears in motion. The anvil is moving as fast as the hammer, and there is no blow, but a simple transfer of strain from one tooth to another without shock. In the case of very small pinions, where the second tooth does not fairly get hold, of rapid reversals, as in an iron rolling mill, or where a fly-wheel is still carrying on the anvil in the first direction, while the hammer has begun to move in another, such extra strength may be necessary, but for gearing in ordinary mechanical uses the factor of safety of 15 to 1 allowed above seems to be ample and sufficient. There is, however, one more very important point to which I should call attention in connection with this reduction of the length of tooth, and that is the necessity of firm and rigid bearings to keep the teeth always in mesh at the pitch line and in perfect alignment. With ordinary spur and pinion gears there is no difficulty in this, if the rule for shafting which I have previously given be followed, and the lengths of shaft on which the gears are placed are of such diameter as to resist pressure, but in the case of bevel-gears especial attention should be given to the bearings which support the gears, so as to prevent them from springing out of their proper right angles, and thus throwing the strain on one corner of the tooth.

* * *

## SHOP KINKS.

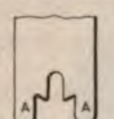
**A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.**

**Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.**

### DIE FOR CUTTING SLOTS–BORING TOOL–VISE CLAMPS FOR FINISHED WORK.

A Canadian correspondent—"W. J. T." of Toronto—sends us sketches and a description of a slotting die that was successfully used for cutting slots on both sides of iron strips so that they would be directly opposite in pairs. The iron strips were about six feet long, 3-8" wide and 3-16" thick. The slots were 1-4" wide by 1-32" deep, each pair being located directly opposite as shown in Fig. 1. The strips to be slotted are placed on edge in the die shown in Figs. 2 and 3 so that it rests on the cross piece or bolster (C). The chisel-edged punch shown at Fig. 4 is so constructed that the edges do not begin to cut until the sides (A A) are entered and supported by the sides of the die (B B) thus preventing the punch from breaking and resulting in two perfectly square and parallel grooves. It is obvious that this method is a big saving of time over cutting the slots on a milling machine.

FIG. 4



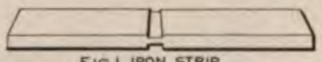


FIG. 1 IRON STRIP.

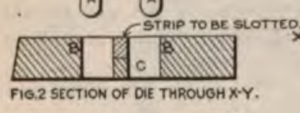


FIG. 2 SECTION OF DIE THROUGH X-Y.

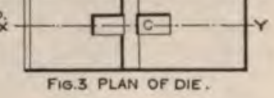


FIG. 3 PLAN OF DIE.

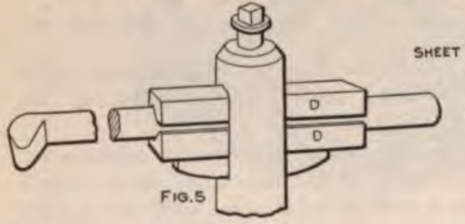
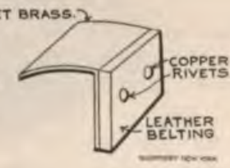


FIG. 5



Boring tools that will work satisfactorily are perhaps the most difficult lathe tools to forge so the following scheme will be found worthy of adoption, especially for the smaller tools. Make two (V) blocks that will go into the slot of the tool-post as shown in Fig. 5 at (D D). Make the tool from round bar steel by hammering over a lip which is a very simple operation compared to forging a complete lathe tool. This tool slipped in the (V) blocks as shown in Fig. 5 makes a very convenient boring tool and one that has a number of advantages over the ordinary form, one of which is that its length can be adjusted to the depth of the hole thus making one tool do for deep or shallow holes.

If leather clamps be once used on vise jaws when holding work that has been nicely finished, their use will be continued, as they are far superior to copper or brass for the purpose. As sometimes used, they consist merely of two pieces of leather belting folded over so as to remain in position when the vise jaws are opened, but in this form they are something of a nuisance on account of being easily displaced and falling to the floor. The idea shown in the sketch shows how the trouble may be avoided. Two pieces of belting are cut to the size of the jaw faces and are riveted with copper rivets to two old brass jaws, thus giving the metal jaws a leather face which will not mar finished work even when tightly clamped by the vise.

### A CONVENIENCE FOR CHANGE GEARS.

Mr. Adolph Munch, St. Paul, Minn., sends a sketch of a device which he has found useful for holding the change gears in place on small lathes. Instead of using the nuts provided for the purpose he shapes pieces of spring wire as shown in Fig. 1. These can be easily slipped into the recess of the stud, close to the shoulder where the thread terminates. While nuts often give trouble by coming off, in consequence of the jarring of the lathe, making it necessary to hunt them up on the floor, these wire fasteners never give any trouble as they always stay in place. Mr. Munch has two fasteners in position as shown at the left in the sketch so that he is able to change the gears easily and quickly without hunting for a wrench or having the trouble of removing and putting on the nuts.

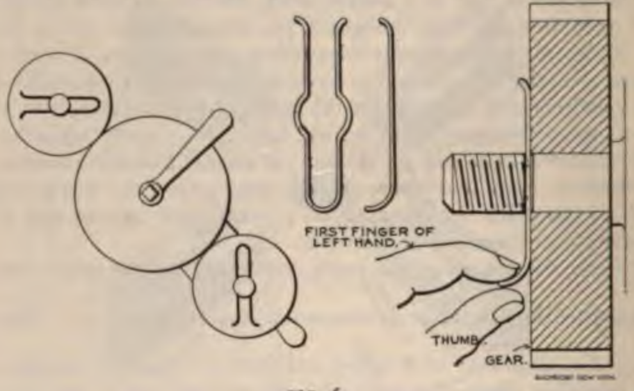


FIG. 6.

### SECTION LINER.

I. R. Ish, Sault Ste Marie, Mich., sends a sketch (Fig. 7) of a section liner which, while in use in many drawing rooms, will be new to some of the younger readers who are now taking up drawing for the first time. He states that he saw the device used at the Michigan Agricultural College and that the outfit consists of a little piece of cigar box wood, (A), which is notched to receive the triangle (B), the notch being a little longer than one side of the triangle. By first slipping the bit of wood and then sliding the triangle along, holding the wood stationary, the triangle can be moved successively the required distance for the space between the lines. Mr. Ish incidentally mentions that the

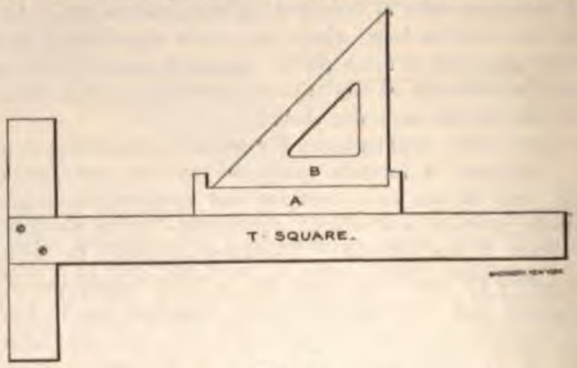


FIG. 7.

Michigan Agricultural College is not, as its name signifies, entirely for those engaged in agricultural pursuits. They have a first-class mechanical course, with large and commodious machine, blacksmith and pattern shop and foundry. Many of these State Institutes throughout the country are doing excellent work by providing thoroughly good courses at a low cost.

### BLACKSMITH'S CALIPERS.

"J. E. S." of Harrisburg, Pa., says there is a little kink in the making of blacksmith's calipers that is sometimes neglected and that is, constructing the rivet so that it will be stationary with the middle leg. The accompanying sketch shows the usual form of these calipers only a little more artistic than they usually appear but the idea is to incorporate in one tool, a means of determining two sizes as is often required when drawing a bar to certain specified dimensions. If the rivet (E) be made circular throughout its length, the movement of either the outer legs (B or C) will influence the other so that it will be almost impossible to get an accurate setting of both legs at the same time. To overcome this difficulty, the rivet should be made with a square part in the middle and the hole (D) in the middle leg (A) filed out to fit. The rivet is shown at (E) with the square part (F). The washers on the rivet are usually regarded as a luxury which can be dispensed with but the square hole—never.

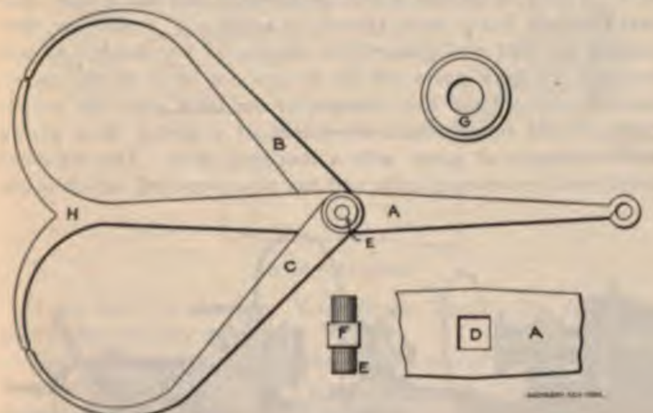


FIG. 8.

### BABBITTING BOXES—SELF-OILING PULLEY.

Mr. J. R. Rand, Brattleboro, Vt., frequently has occasion to re-babbitt armature and motor axle boxes for electric cars, and has devised the arbor shown in Fig. 9 for the purpose. The body or cylindrical part is formed of three pieces (A, B and C). (A) and (B) are castings with the raised portions (d d) which make the oil runs in the babbitted box. The wedge (C) is driven out after the babbitt has been poured, thus relieving pieces (A) and (B) and enabling them to be withdrawn. The plates (W. W) serve to keep the parts of the arbor as well as the shell of the boxes in place while the babbitt is poured.

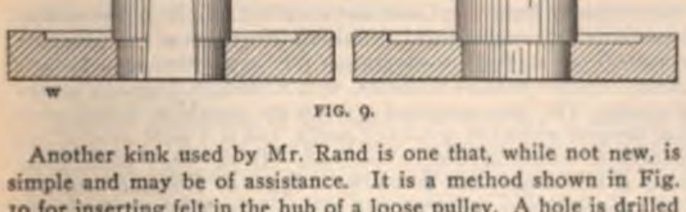


FIG. 9.

Another kink used by Mr. Rand is one that, while not new, is simple and may be of assistance. It is a method shown in Fig. 10 for inserting felt in the hub of a loose pulley. A hole is drilled near the bore of the pulley and then a slit is sawn between the bore and the hole that is to contain the felt. This felt will hold oil a long time and gives satisfactory results.

### SCREW-NAIL-BOLTS.

Mr. Robert Grimshaw sends the following idea:

Where much erecting has to be done there is need of scaffolding and the more cheaply and quickly this can be put up and taken down the better. It usually happens that the successive stagings come in regular multiples of height, say seven or eight feet between, and if it can be arranged to use the same material over again, the better. For this work round spikes with a large head and quick thread, with a pitch of about two-thirds of their length will be found profitable as they can be driven with a heavy hammer and taken out with a brace or a socket wrench, without damaging the wood. Such a one is shown in Fig. 4. The time taken to bore holes for lag screws is saved. The spikes are necessarily round and should be slender. Square heads are the cheapest to make and loose washers are better than those forged out of the solid because cheaper and protecting the wood equally as well. For driving it may be well to have a steel head to fit over the squared head of this "screw-nail-bolt" against which to strike. This head should, of course, have a handle.

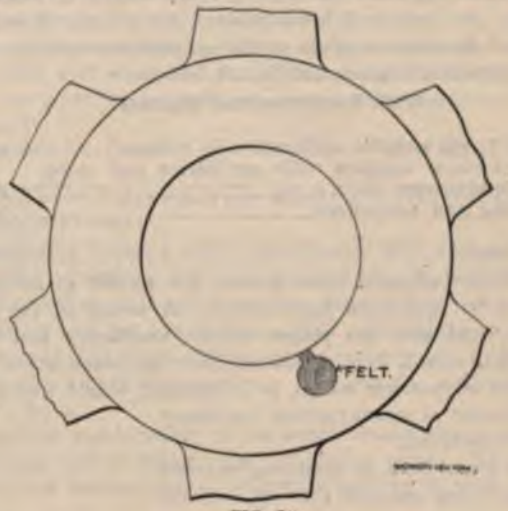


FIG. 10.

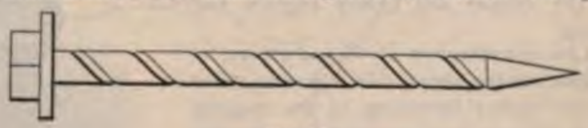


FIG. 11.

* * *

## STEAM TURBINES ON LARGE VESSELS.

The successful results obtained with a Parsons' Turbine in propelling the yacht Turbinia at a high rate of speed has led many to ask why, if the steam turbine is so successful on a small scale and will produce a horse-power with a very small weight of engine, it would not be adapted to propelling merchant and naval vessels. Mr. Parsons himself believes there is no reason to prevent its application to fast vessels of larger size, including ocean liners and cruisers, and it is claimed that the advantages in these latter cases would be as great as in the former instances. It is also said experience has shown that the larger the scale on which the turbines are made the greater is the ease in fulfilling the conditions for the highest economy in steam, with a minimum of weight. In a series of articles in London "Engineering" Mr. Parsons has presented some interesting facts about the steam turbine, among which are the following dimensions and weights for the machinery for a vessel 600 feet long, as he has estimated them. First comes his estimate for a steam turbine equipment, and then follows the estimated data for an installation of reciprocating engines. It should be noted, however, that there is no reason why water-tube boilers should not have been taken for comparison in each case, instead of in the first case only, as Mr. Parsons has done.

**Turbine Equipment.**

| | |
|---|---|
| Length between perpendiculars | 600 ft. |
| Breadth, extreme | 63 ft. 3 in. |
| Depth, moulded | 42 ft. |
| Draught to bottom of keel | 28 ft. |
| Displacement | 18,000 tons |
| Total bunker capacity | 5,000 tons |

| | Tons. |
|---|---|
| Boiler-room weights with water in water-tube boilers. | 1,364 |
| Engine-room weights with auxiliary gear and water in condensers | 822 |
| Shafting and propellers | 210 |
| Total. | 2,396 |

With 38,000 indicated horse-power, the weight of machinery is 141 lbs. per indicated horse-power. As compared with the above, the following are given as the weights for a similar vessel with reciprocating engines and Scotch boilers:

**With Reciprocating Engines.**

| | Tons. |
|---|---|
| Boiler-room weights with water in boilers | 2,225 |
| Engine-room weights with auxiliaries and water in condensers. | 1,220 |
| Shafting and propellers | 305 |
| Total. | 3,750 |

With 26,000 indicated horse-power, the weight of machinery is 323 lbs. per indicated horse-power. A vessel of the above size, and fitted with the steam turbine machinery and water-tube boilers, would, it is estimated, have an ocean speed of 26 knots. The advantages which, it is claimed, would result from the substitution of steam turbine machinery in a liner would be:

1. A reduction of total engine-room weight to about one-half that of ordinary engines.

2. A small reduction in steam consumption per indicated horse-power.

3. Complete freedom from all vibration from the main engines and a great reduction of vibration from the screw propellers.

4. A smaller engine-room staff to deal with the simpler and lighter engines and shafting.

5. Less consumption of oil and stores.

Regarding the above, Mr. Parsons states that the perfect balancing of the engines permits of very light engine-room foundations, and obviates that stress or strain on the hull which is produced by reciprocating forces of ordinary engines. The absence of lubricant from the internal parts of the engines is a benefit to the condensers and boilers. It diminishes the cost of cleaning and repairs, and enables very high boiler pressures to be used without risk. It is proposed that the steam should be reheated between the high- and low-pressure cylinders by coils of steel tubes containing steam at boiler pressure. Compound feed heaters, supplied with steam drawn from several points in the expansion in the main engines, would raise the temperature of the feed to above 212 degs. Fahr. The exhaust from the auxiliaries would also be added to one or more of the heaters. The trials of the Turbinia showed a total consumption of steam for all purposes of 14½ lbs. indicated horse-power of the main engines at 31 knots, but in a liner the consumption would undoubtedly be less, owing to the larger size and more perfect expansion, the higher boiler pressure, better vacuum and other minor details. Smaller size of the screw propellers diminishes vibration due to uneven action of the blades in the steam lines of a vessel. Smaller diameter also permits of some eight feet more immersion above the tips of the blades, so that the evils of screw racing in heavy weather will be mitigated and the vessel better able to keep her speed.

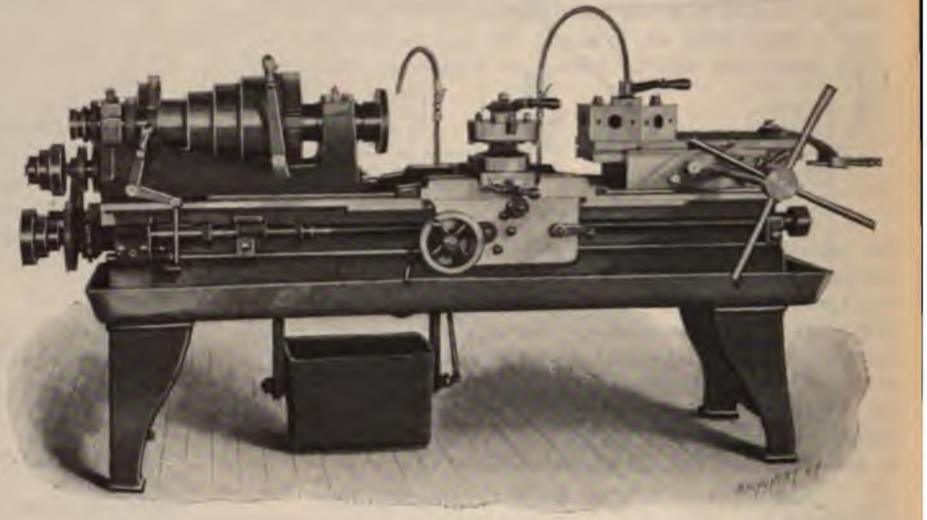
With the steam turbine the turning moment on the shafting is absolutely uniform, and these engines have much more momentum (or flywheel inertia) than ordinary engines. They will, therefore, not gather speed so quickly should the screws top the surface, and the engine governor will have more time to come into action and prevent racing. The shafting is only about one-half the usual diameter for equal total indicated horse-power, and can, therefore, be much more easily dealt with by the staff, and spare parts more easily carried. The four shafts are an additional safety against total break-down of the engines; and should one of the engines break down the other three are not interfered with, as they are quite independent excepting as regards the steam supply, which is controlled by valves. The small head-room required for the turbine engines and their quiet working permits of cabins being placed over part of the engine-room.

* * *

## A UNIVERSAL TURRET LATHE.

The Prentiss Tool and Supply Co. have brought out a turret lathe intended for the manufacture of duplicate parts from bar stock or from castings. It contains some unusual features and appears to be an uncommonly well made and substantial tool with a large capacity, the manufacturers claiming that it is able to turn out as much as three ordinary lathes on the work for which it is designed.

The machine is 20" swing and has a bed 7' long, which gives ample capacity for any duplicate work that is likely to be done on it. The head spindle is 3½" in diameter and has a large hole clear through, being large enough to admit a 2" rough bar, thus making the tool well adapted for the use of bar stock. As will be noted the back gears can be thrown out or in by the movement of a lever, and two changes of the back gear can be obtained by the longitudinal movement of a pinion, thus giving twelve changes of speed with a four-step cone. The six-sided turret revolves automatically and has power to feed, which is obtained from a pulley on the end of the lead screw, thus enabling a large variation of feed to be obtained without complication. The turret has an automatic stop for each tool, and each stop may be adjusted without interfering with the others. An automatic stop is also provided, which is operated by the rotation of the lead screw. The direction of the feeds can be reversed by a lever shown in the front of the head-stock or by a handle at the left side of the tool carriage. An oil pump is provided and the turret is constructed so that oil may be forced through the hollow center, thus enabling the use of twist drills having oil channels and other tools requiring internal lubrication. A tool turret is provided in place of the usual tool-post, which has slots provided for four tools, that may be either the ordinary forger tools or any of the tool holders in common use. The arrangement for clamping the tools is somewhat novel, being a combination of a wedge and screw which locks the tool from the side. The tool turret is revolved by the hand lever shown at the top and a single movement of this lever to the right and back unlocks the turret, revolves it and locks it again in the new position. We are informed that the weight of the tool is about 3,400 pounds.



NEW TURRET LATHE.

* * *

In "Sparks from the Crescent Anvil," T. F. Dolby describes how he once "put on" stock by taking advantage of the principle that steel will expand in hardening. He had a steel ring ¾-inch thick, 4 inches outside diameter, with a smooth hole 1½ inches diameter. The ring was used as a die for punching medals, and had become worn and scratched inside, and if it were ground out smooth it would have been over-size. It had once been hardened at a low heat, and he heated it again to a higher temperature, removed it to a faucet, laid it on a board, turned the water into the hole and left it until cold. Result, the hole was smaller and could be ground out without making it larger than 1½ inches.

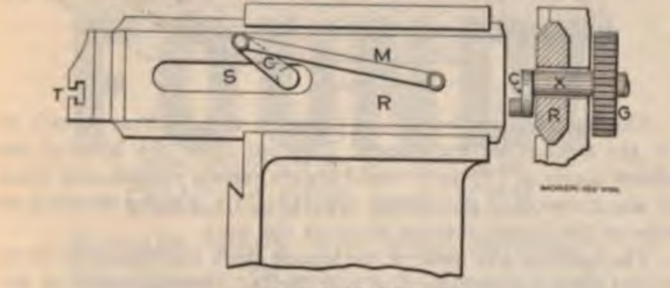
# LETTERS UPON PRACTICAL SUBJECTS.

## AN OLD SHAPER DESIGN.

*Editor* MACHINERY:

While in a railroad shop not 100 miles from Worcester I came across a shaper which was a little out of the ordinary and which was new to me in just this form.

As will be seen from the sketch, the ram is of deep vertical section, running in V guides. The power is transmitted through gear G, shaft X, crank C and rod M to the ram R. The slot S allows the ram to move past or around shaft X. The crank was, I think, slotted, and the ram end of rod was adjustable for varying strokes and positions of the ram.



AN OLD SHAPER.

It was built by the New York Steam Engine Co. and bore a patent date of July 23, 1861.

The base was round, but the saddle moved on a flat way in front as well as vertically on planed ways, so that it in no way interferes with our friend Forbes' milling machine.

FRANK C. HUDSON.

Tombstone, Arizona.

* * *

## DRAWING OVERLAYS.

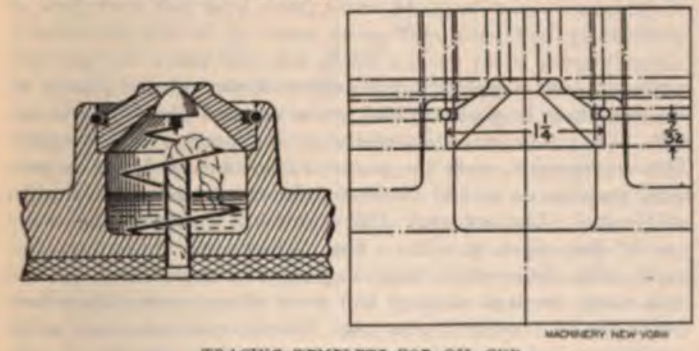
*Editor* MACHINERY:

In drawing complicated mechanisms the scheme described here, to save time and attain clearness, may interest readers of MACHINERY, as it has not been shown in any drawing treatises with which the writer is familiar.

The innovation lies in the use of tracing cloth between the original paper, and final finished tracing, as follows:

1. Paper.—This drawing with pencil outlines of machine, gives the assemblage of related parts or those which lie furthest from the eye.

2. Tracing Cloth.—Penciled train of mechanism or series of parts nearest to observer. As the first drawn lines show through tracing cloth, the relation of all is seen but the inevitable corrections and erasures on second plane are made without disturbing fundamental work on first paper.



TRACING TEMPLETS FOR OIL CUP.

3. Finished Tracing.—Made over both the foregoing. The first tracing being easily followed for inking gives those parts which are naturally in full lines, and when inked the first tracing may be removed without necessarily disturbing the register between No. 3 and No. 1 which may then be traced and the drawing completed.

Another application of this same prinpciple lies in making, on tracing cloth, a light outline of any frequently repeated machine detail, and running reference lines from the measurement points of detail to edges of this tracing template. Placing this on a drawing in progress will show directly if space at disposal will permit of the use of part, and when most favorable location is seen the part can be drawn in without making a single measurement other than simply extending the reference lines from the edges of the overlay.

For example: Take the self-sealing oil-cup illustrated herewith. After an experience with several hundred this has proved so good that it is used on any common bearing, and is of course drawn many times on different machines.

The tracing template for this is shown and its application will be readily seen from the preceding. Only the finished dimensions are given on template which may be repeated on the drawing.

New Britain, Conn. ROBERT S. BROWN.

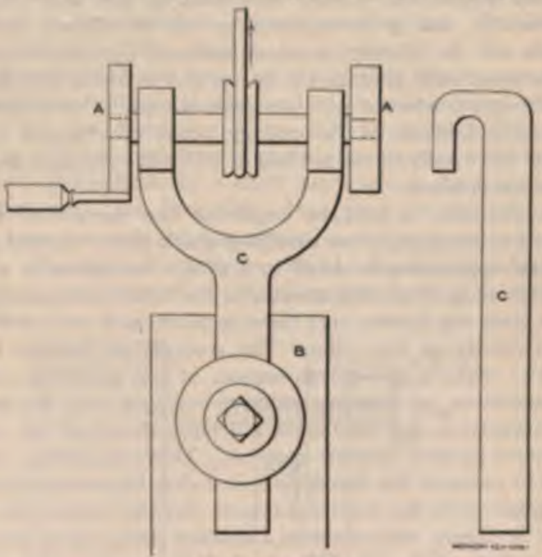
* * *

## PIVOTING BALANCE STAFFS IN WATCHES.

*Editor* MACHINERY:

In pivoting balance staffs considerable skill and patience are required in doing the work by the usual process, which is to drill into the broken staff and drive in a piece of steel wire as tightly as possible and yet not split the staff. This piece of pivot wire is hardened and tempered to such a degree that it can just be turned with a keen-edged graver. The process is slow and oftentimes tedious.

A skillful watch-maker of my acquaintance has adopted a different way and is doing very satisfactory work. He grinds the pivot to the desired shape instead of turning it, taking less than one-half the time required for the latter operation. In MACHINERY May, 1897, is shown a handy grinder which is used for this purpose, and the essential features of the sketch are reproduced herewith. (AA) are the carborundum wheels; (B) is the slide rest, and (C) the frame of the grinder referred to. (C) is shaped as shown at the right of the sketch and the axle of the grinder is held in place by the pull of the belt as indicated. The arbor can be easily slipped out so as to change the positions of the wheels if desired. The wheels should be driven with a small belt from a countershaft at the back of the bench and as the arbor does not run in solid bearings, but is free to go and come as much as the elasticity of the belt will allow, there is no danger of pressing the wheel so hard against the pivot as to break it off. It will be observed that the grinding wheels are at the back of the work and therefore the workman can see just how he is progressing.



GRINDING RIG.

Some workmen may say that a fine pivot cannot be made in this way, but nevertheless it is being done every day, and the public is being benefited by having to pay only about one-half the usual rates for pivoting. F. H. F.

* * *

## THE VALUE OF A PRACTICAL EXAMPLE FOR ABSTRACT ANALYSIS.

*Editor* MACHINERY:

An editorial in the September MACHINERY under the "New School Year" reads in part "First and last there is a great deal of fault found with the technical schools because graduates do not always take hold of practical work with the degree of success that they ought to after four years of work. If these criticisms are justified it is probably because the professors fail to impress their students with the importance of getting in touch with actual machine construction during their years of study."

True, a part of these criticisms are justified, and a part, also, unmerited. Too often the practical man, as opposed to the technical graduate, has a strange antipathy for the college man simply because he is a college man, and looks upon the latter's efforts with marked cynicism and apathy. The self-made engineer is truly to be commended for his perseverance and thrift, but his success, after years of uphill toil, does not justify him in condemning the young graduate because his four years of general technical training does not fit him for undertaking every conceivable branch of machine construction without further experience.

It is not however, the object of this paper to uphold the technical graduate, but to state some reasons why professors fail to impress their students with practical applications of abstract theorems. Take, for example, that particular branch of kinematics which pertains to the analysis and synthesis of variable motion mechanisms. In all treatises of kinematics, from the masterly analysis of Reuleaux on the Functions and Principles of Mechanism to the very latest works on this subject, the Whitworth quick return motion, the oscillating quick-return, etc., are exhaustively discussed in abstract, no attention, however, being paid to the practical application of these principles to shapers, planers, pumps, etc. True, some institutions have small models of these appliances, which, unfortunately, are only examined superficially, and in no instance, as can be learned, are these models and the abstract problem analyzed in conjunction.

Interviews with graduates from various technical colleges, and experiments conducted with the present class of undergraduates at Armour Institute of Technology, prove conclusively that the trouble lies wholly in the method in which the practical and theoretical are studied.

For example, a problem requiring the theoretical velocity analysis in abstract, of an oscillting quick-return motion and its practical application in detail to a shaper was given to a representative class of undergraduates in the following manner:

The class was divided into three sections, each section working independently of the other. The students of Section I. were asked to make a theoretical analysis of this problem, and after its completion, to examine a shaper equipped with the mechanism in question, and then make a detailed design of the machine as applied to their abstract theorem. Those of Section II. were asked to examine the shaper first, and after becoming thoroughly conversant with the modus operandi, were to analyze the mechanism in theory and complete a detailed design as in Section I. The students of Section III. were asked to analyze the theoretical problem and the shaper in conjunction and proceed as in the other sections. Section III. to a man completed the problem first, Section I. next, and Section II. last. Similar problems were given throughout the entire year and the different sections were interchanged, but the result was practically the same. Examinations on this work at the end of the quarter were decidedly in favor of Section III. Similar experiments were conducted with the class in governor design, and the results prove conclusively that a study of the abstract problem in conjunction with its practical application impresses itself more readily upon the students than the systems now in vogue, and, of still greater importance, makes a more lasting impression.

G. F. Gebhardt,

In charge Dept. Machine Design,
Armour Institute of Technology, Chicago, Ill.

* * *

## DRILL-ROD CHUCK—HOT AND COLD WATER.

*Editor* Machinery:

Machinists and tool makers find it convenient to use cold rolled steel shafting and drill rods for much of their work. I use drill rods for many purposes, but have found it difficult to devise a way to hold them so that they will run true in the chuck. I made a bell chuck with a set screw on one side, having the hole of such a diameter that the rod was a snug fit in it; but in a short time the chuck was out of true and satisfactory results could not be obtained with it. Another chuck with a taper nut also proved just as unsatisfactory. I could not induce the "old man" to buy a draw chuck, so I made one like sketch, Fig. 1.

(B) is the body of the chuck and was made to screw on to the spindle so that the threads would be a snug fit. A sleeve (A) was made of unannealed tool steel, and on one end of it a buttress thread was cut as shown in the sketch at (T). Six slits were sawn in the end of the sleeve on which the threads were cut, and the bushing was forced into the body so that it was solid with it.

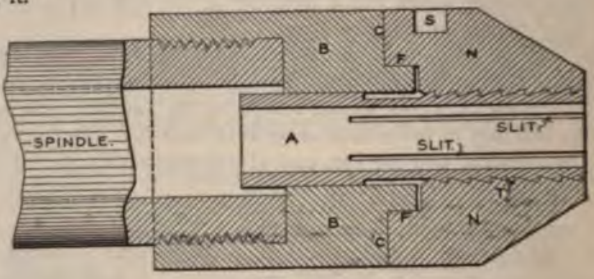


FIG. 1.

The nut (N) was bored and threaded with buttress threads to fit the threads on the sleeve. This nut fitted the body of the chuck nicely at (F) so it would always remain central, and when it was screwed up against the body at (C C) it had a tendency to slip on the thread, thereby gripping the work.

The bushing was made of the largest stock that the chuck body would hold and with the size hole desired. Bushings having different diameters of holes can be used to fit different rods. (S) is a hole for the spanner wrench.

Another little device has been very convenient for our use at the shop and is illustrated in Fig. 2. We wanted warm water to wash with, and I piped from an elbow in the exhaust pipe to a hot water tank as shown at (B) in the sketch. This pipe was ¼ inch in diameter and ran nearly to the bottom of the tank. This arrangement made the water too hot and so I put up another tank shown at (A) in the sketch, which was supplied with cold water. The hot tank (B) was then fed from the first one of the pipes at (C). The connections shown underneath, with their valves, thus enabled us to draw either hot or cold water, or parts of each, and water of any temperature between the two could be obtained. This arrangement gave us a satisfactory hot and cold water system for the shop.

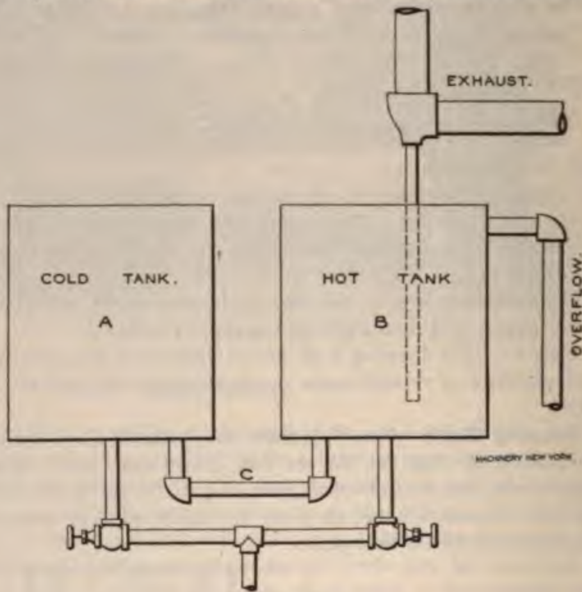


FIG. 2.

Decatur, Ill. W. A. Bright.

* * *

## FOUND!

*Editor* Machinery:

The ingenuity of the New England Yankee is, so they say, proverbial, but I recall an incident that causes me to question his right to this reputation as compared to that of his kind in "Ole Virginy." It was an unusually cold morning and I was waiting for a train at a town of considerable importance in the above-mentioned state. The mercury in the thermometer was only a few degrees above the zero mark and I stepped into a small machine-shop near by to get warm. (Somehow "machine shop" always seems to spell "home" to me.) This particular shop was a very humble, tumble-down home however, hardly large enough for two men to move around in, and I found the proprietor with an overcoat, mittens and a thick winter cap on, stuffing wood into the top of a "boot leg" stove. There were great cracks in the floor that would permit a lead pencil to pass through quite readily, but then the shop was set up on boulders so that one could crawl underneath and recover anything that fell in these cracks, of whose proximity I was reminded by the way the wind whistled through them. Well, I shivered and shook and my teeth chattered and I told the proprietor I should think his feet would freeze in such a place. Without saying a word he stuck his foot up on the top of the stove, pulled up his trouser leg and revealed to my astonished gaze an inch and a quarter shank with the black paint cracking off of it as it does off an old wagon wheel. Pausing between every word to whittle off a chip from a stick of wood he had in his hand, he remarked drily: "What do you think of that for a shin bone? I'll tell you what it is, there's nothing like being adapted to one's surroundings. I suppose you are also wondering how I can earn enough to keep even that hard wood shank as fat as it is. I couldn't if I were not able to do many things that most mechanics think they can't do if they have not served a seven years' apprenticeship to learn. I am prepared to make anything from a carpet tack to a cyclone. Here, put one of my business cards in your pocket; you will find a few of my specialties mentioned on that. Of course, a shop like this don't provide the most sumptuous living and besides having to attend to business, I have to raise my own chickens. But my neighbors, sad to say, are not so self-reliant nor so conscientious about leaving other people's property alone, and so, one morning last spring, I had but one pullet and a rooster left out of my whole flock, and to make matters worse that pullet broke her leg. But in spite of all this I didn't despair. The accident to my own leg had given me experience, so I cut off the chick's useless foot and bound up the leg. The wound healed rapidly; when it was quite well I stuck a clothes pin on to the end of the stump for Mrs. Biddy to hobble around on. You ought to see how sleek and fat she grew; and one fine morning I found her with a brood of chickens around her who appeared to be listening to her 'fo' the war' and 'ku-klux' stories. But the most curious part of it is, that each of them hatched out with one 'peg leg.'"

**FOUND!**

ONE WHO CAN DO ALL KINDS OF

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(Exact reproduction, with name omitted.—EDITOR.)

I took it for granted that my friend of the wooden shin could thoroughly adapt himself to circumstances and didn't wait to hear any more. When I got settled in the train I took his card out and looked at it. I will enclose it herewith so that you can add a reproduction of it to this letter; it may serve as a pointer for the young Yankees who think of going down South to start in business when they have finished their apprenticeship.

I don't see rock-maple shin bones mentioned as one of his specialties but I am confident that he made the one he walks on.

MILO.

* * *

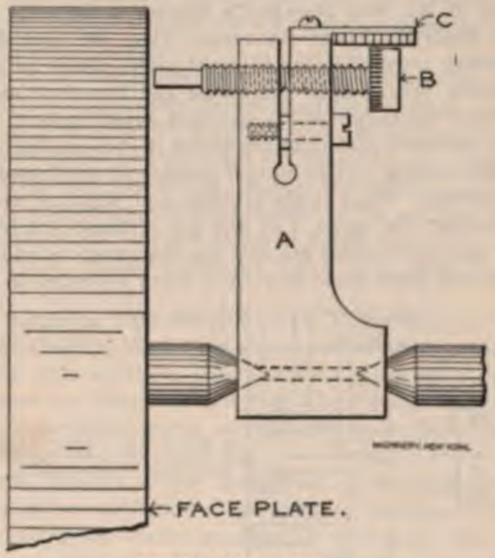
## TESTING CENTERS—POINTS IN LATHE DESIGN.

*Editor* MACHINERY:

In his article upon testing and adjusting engine lathes, in the last number, Mr. Van Dervoort mentions the time-honored method of testing the alignment of the centers by turning a short distance at each end of a bar placed between the centers and then calipering the two turned portions. If they are of the same diameter the two centers are in line.

This method is an accurate one, because it is possible to measure the diameters of the bar very closely with a micrometer, but it has the objection that it consumes considerable time. Where one is operating a lathe without a taper attachment, and has to set over the tail center frequently, it is annoying to have to hunt up a bar and center it and take the time required to turn up the ends two or three times and test them for uniformity.

The accompanying sketch shows a device which would not only be as accurate, or perhaps more accurate than the method just described, but it would be more rapid, and it would pay to have such a tool in the shop. The bar A is drilled and countersunk on opposite sides of one end to fit the lathe centers, and on the other end there is a micrometer screw which is made long so as to be adapted to lathes of varying size. To use put the instrument between centers, as represented in the sketch, clamp the tail stock and turn the bar until it lies in a plane in which the two centers are supposed to lie when out of adjustment. Turn the measuring screw until its point touches the face-plate. Note the reading of the screw, move it back two or three turns and indicate by a chalk mark where the screw came in contact with the face-plate. Now turn the face-plate half around, together with the instrument, and take a second measurement. The difference between this and the first measurement will give an indication of the distance that the two centers are out of line.



TESTING INDICATOR.

I have a device similar to this, only not so elaborate, which I have used for a number of years and have found very convenient. There is no micrometer screw, and I depend on a sliding pin and set screw with a "feeler" in the shape of a few thicknesses of paper between the pin and face-plate. The idea is not original with me, but I do not know who should have the credit for it. The device was described to me by a special apprentice, who said he had seen it at college.

In my last letter I expressed an aversion to novelties in shaper design, when as good, or better, results can be obtained by adhering to well-established practice and making all the parts extra strong and heavy. In the case of engine lathes, however, there is one part that is bound to wear out, however generous its proportions, and that is the lead screw. There would be no serious objection to this if the wear were uniform on the whole length of the screw, but this is impossible, as every lead screw is used more at a point a short distance from the head stock than elsewhere, and the pitch gradually changes from this point to the end nearest the tail stock, where the wear is practically nil. Why not, then, make the lead screws of engine lathes reversible, so they can be turned end for end? One end could then be used for "common" and the other kept for "best," or until the first end became so bad that it was unsuitable for any purpose. Here is an opportunity for "freak" designs, as you style them, where the problem does not seem to be susceptible of solution by more legitimate means.

While on engine lathes, I cannot refrain from mentioning that a point needing stiffening in many of this class of tools is the tail stock spindle. It would do no harm if it were made half again as large in diameter as is the custom. It may be argued that when heavy work is to be turned the tail stock itself should be moved up, instead of extending the spindle, but nevertheless it is more convenient to extend the spindle than to slide along the tail stock itself, and as long as this is the case the spindle will continue to be extended, and very far, too, sometimes, by most lathe hands. This is the end of the lathe that has to take the strain of most of the heavy cutting, and, in my opinion, the tail stock spindle should be more substantial.

Olin Snow.

* * *

## TESTING ENGINE LATHES.

*Editor* Machinery:

I noticed in the October issue of Machinery an article of interest on the testing and adjustment of that universal tool—the engine lathe. Every machinist running a lathe ought to know how to find errors in the alignment of his machine and how to correct them, but it is a notorious fact that a large proportion of the best lathesmen are at a loss to test their machines in any other way than by turning or boring a sample piece. While this test may detect inaccuracies, it, however, is a very poor guide for the correction of the same, simply because the test does not show where the inaccuracy lies. It is evident that any method, no matter how refined it may be, is not of much value if it does not show exactly where we are to go to correct the fault. For this reason I feel compelled to criticise some portions of Mr. Van Dervoort's article, as the tests mentioned do not positively locate the error. Thus, he says that to test the carriage cross-slide for being at right angles to the axis of the spindle, take a light cut across the face-plate and test the accuracy of the facing with a standard straight-edge. If the face-plate be perfectly plane the alignment is correct; but is it? Suppose, after testing a lathe in this manner, it was found to bore a hole tapering? What is the trouble, and what are we going to do to correct the fault? Cut and try methods are tedious, and in this case the chances are that the inaccuracy would be aggravated in one place while they were being corrected in another.

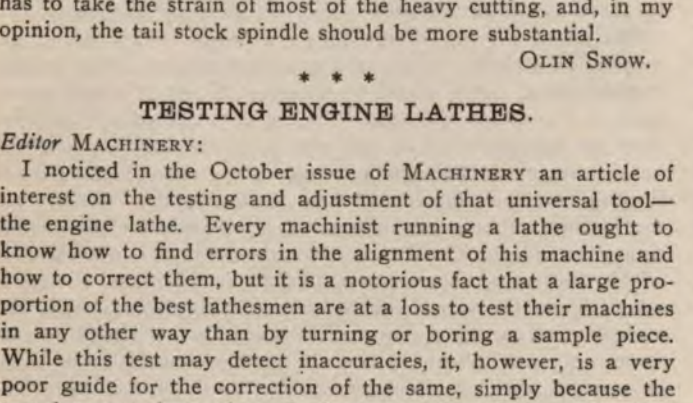


FIG. 1.

There is, however, a simple method for testing and locating the errors of an engine lathe which is used to a limited extent, but which does not appear to be generally understood. The materials for the test are those that can be found in any shop, and but little work is required to rig them up into a reliable testing apparatus. Suppose we are to test an 18" lathe that is six feet between the centers. A round bar of iron 2" in diameter and about five feet long will be required as the principal part of the testing appliance. This bar must be centered nicely, the holes being drilled and reamed with a center reamer of the same angle as the centers of the lathe. A hole must be drilled through the bar near one end, and another should be drilled and tapped at right angles to the first for a set-screw G to hold the angle-piece C shown in the accompanying figures—1, 2 and 3. The part C should be made from ⅝" iron rod, so it will be quite stiff, and should have a hole drilled and tapped in the outer end for the screw F. The head of this screw ought to be rounded to approximately spherical shape, or bluntly pointed, so that if the screw be adjusted out or in, the point of contact will remain about the same distance from the center of the face-plate A. One end of the bar B should be turned and finished smoothly for a short distance from the end opposite that carrying the part C.

The first test to be made may properly be to determine whether the center bearing is bored so that it is not slightly eccentric with the center of the spindle. The determination of this error is, however, a minor matter, as there is not one lathe in a hundred but the center will run out slightly when placed in a position diametrically opposite to that in which the point was turned. The result is that machinists generally mark the center for the spindle when it is trued up so that it can always be put in that position when used. To test it for eccentricity, however, all we need to do is to turn the point off nicely and then remove the center and replace it in the hole so that it will be turned one-half way round. Then place the bar B on the centers, with the turned part next to the face-plate. The cross-slide is run up till the end of L touches the turned part of the bar B with a piece of tissue paper held between the two. Now hold the bar stationary on the centers and revolve the face-plate slowly, and note whether the pressure increases and decreases on the tissue paper during the revolution. If it does not, with the center in different positions, the center bearing may be regarded as being accurately located, but it will almost surely show a variation, as the test is quite a rigid one.

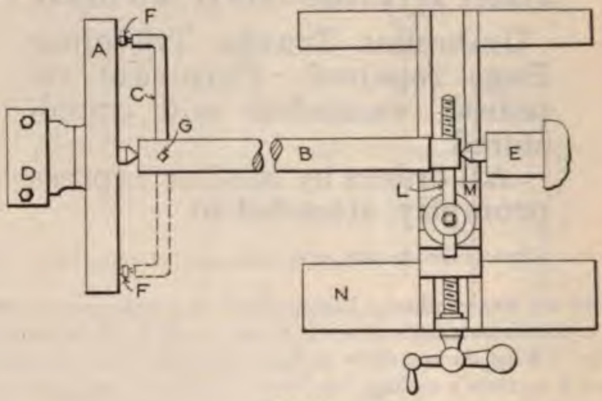


FIG. 2.

Having tested the live center, and leaving it in a position of truth, we are ready to try the tail-spindle E. With the turned end of the bar B next to the face-plate, adjust the cross-slide so that the tissue paper is lightly held between the bar and the end of L. Without disturbing the adjustment of the cross-slide move the carriage to the tail-stock end of the lathe, as shown in Fig. 2, and reverse the position of the bar B on the centers, but do not screw the tail-spindle up until the tissue paper has been inserted between the bar and the end of L. If the tissue paper pulls from between the two with the same resistance in both cases, the lateral adjustment is correct for that position. Now loosen the tail-stock and slide it along for a distance equal to the maximum movement of the tail-spindle in the tail-stock and try the new position in the same manner. If there be no change, the alignment and position of the tail-spindle is correct. The same method may be pursued in correcting the vertical alignment, only the part L should be of such shape as will enable the end to come above the bar B. Precautions must be taken in all cases to have the tail-spindle screwed up with the same degree of pressure, which should be just sufficient to prevent shake on the centers.

Having tested the alignment of the tail-stock, the truth of the head spindle may be tried for parallelism with the axis of the lathe. With the apparatus in the position shown in Fig. 1 the screw F is adjusted towards the face-plate until the tissue paper is lightly held between the two. Now turn the face-plate and the bar B one-half rotation and then try the paper. If it be held tighter or looser, it shows the axis of the spindle to be out of parallel with that of the lathe. If the paper be loosest on the side next to the operator, it shows that the axis of the spindle has the position shown exaggerated in Fig. 1 by the line J K, H I being the axis of the bed. To correct this fault it will be necessary to set the boxes at the face-plate end of spindle over until the axis of the spindle coincides with that of the lathe. It will then be necessary to readjust the tail-spindle alignment.

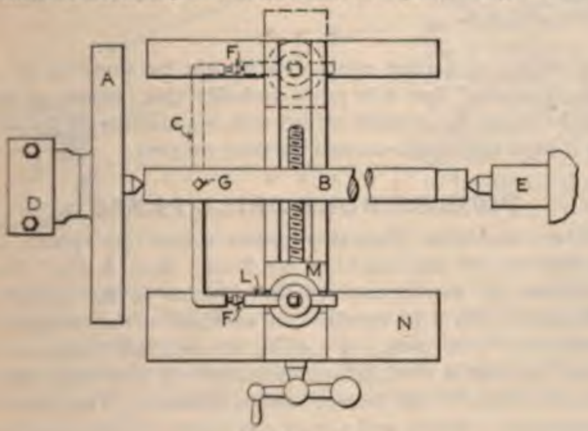


FIG. 3

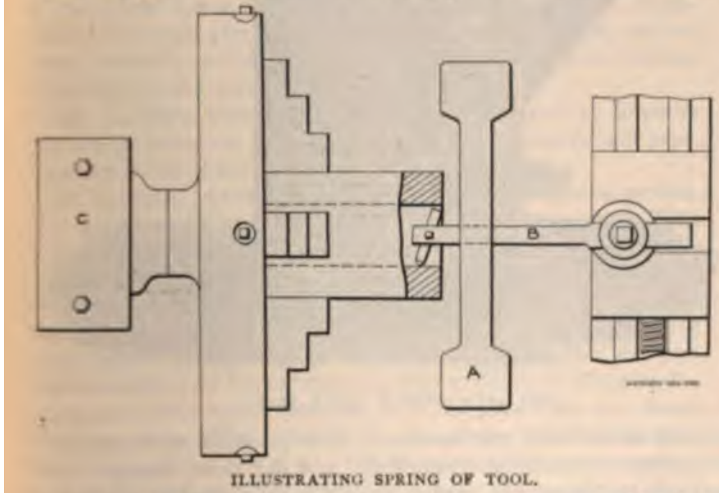
After the correct alignment of the head- and tail-spindle is obtained the cross-slide may be tested for its right-angle position. With the cross-slide in the position shown in Fig. 3 and the bar B with the angle-piece turned as shown adjust the tissue paper between F and L, then, without moving the carriage, run the cross-slide M over and turn the bar until the end F again abuts against L as shown by the dotted lines. If the tissue paper be held with the same degree of resistance in this position, the cross-slide is at right angles with the spindle and will face work to a plane surface. A lathe adjusted in this manner should face work to a plane surface, bore a hole of uniform diameter and turn straight within reasonable limits. NEMO.

* * *

## SOMETHING MORE ABOUT SHAPER SLIDES.

*Editor* MACHINERY:

I noticed a letter in the October issue of MACHINERY which commented on the form of shaper slide suggested by the writer in the September issue, but apparently Mr. Gray does not think the scheme to be very feasible, as he works in an idea of his own, which is supposedly superior. As every one has a right to his opinions, I cannot quarrel with him, but as some of my friends have expressed their surprise at what they are pleased to call a freak design, I have felt called on to offer another argument which is thought will put the idea in a clearer light. As those who read the letter will remember, the argument was advanced that a certain amount of spring was unavoidable in any feasible form of shaper ram, and in view of this fact, a form was suggested which would make the defection uniform. The great objection appears to be with those who criticise the arrangement, is that it weakens the support of the ram when working short and close to the frame. The force of this objection is admitted, and attention was called to it in the original letter, but the writer considers the benefits to be derived to more than offset any disadvantages.



ILLUSTRATING SPRING OF TOOL.

A good engine lathe under ordinary circumstances will bore a hole that will not vary from parallel over one-half thousandth of an inch in a distance of six inches, and, in fact, this error would probably condemn the tool on very close work. The boring tool is held in the tool-post at a distance from the point that will approximate eight inches, and the spring of the tool even under the most favorable circumstances is many times the allowable error. In homogeneous material, however, the amount of spring is uniform, which gives a uniform result in the hole being bored. Suppose, however, that some machinist has noticed the springing of the boring-tool, and in endeavoring to correct the fault he devises the steady-rest shown in the accompanying sketch, in which (A) is the steady-rest bolted to the lathe-bed and having a hole bored for the shank of the tool (B) which is thus solidly held to the work when starting the cut. It does not need any prophet to tell what the inevitable result must be, as the further the tool progresses on its way, the greater the amount of deflection, so the hole bored can by no possibility be parallel. It seems to the writer that the conditions met by the shaper ram are exactly the same, and that the only way to overcome the evil is to accept the logical solution, which is to make the deflection uniform at all points of the stroke.

Newark, N. J. F. EMERSON.

* * *

## FAULTS IN SHAPER DESIGNS.

*Editor* MACHINERY:

Nearly all modern shaper designs are such that they cannot truthfully be called tools for doing accurate work, but their popularity is partly due to their ready adaptability to many kinds of work, and mainly to the fact that most of the work done on them does not require accuracy.

The pillar style is the most inaccurate of all designs, and no matter what shape or how heavy are the ram and guides a long piece cannot be planed straight, from the simple fact that the fit in the guides must be at least free enough to allow oil to flow between the surfaces and the long overhang of the ram multiplies the effect of the free fit. Furthermore, on account of unequal wear the guides become curved, and it is then impossible to plane anything straight.

As if that were not enough, the table is also another source of serious error. The table saddle is always shorter than the rail and is used most in the center, so that the table soon wears and sags more at the middle of the rail than near the ends. The table support is radically wrong, because the weight of the table and all on it overhangs, and the pressure of the tool cut crowns the whole. Of course all these faults of design have been recognized, and some notable attempts have been made to avoid them.

Without departing from the pillar style, the most heroic effort was made by the Fox Machine Company, who adopted the milling machine style of table, which almost eliminates the evil effects of wear and overhang of table. Their design of ram and guides, while an improvement on the usual style, is not a complete remedy for its evils.

The design, however, shows throughout marked evidence of a full recognition of the faults of the ordinary designs, and is an intelligent and praiseworthy attempt to overcome them. To remedy somewhat the evil of the overhanging table, some makers use a sliding prop under its outer end; but this is a nuisance, because it must be adjusted every time the table is raised or lowered and it is also about in the worst possible place a sliding bearing could be placed if it is to be kept clean and in good working order. The fact is that such a device is a confession that the table needs a radical change of design.

The traversing head style of shaper has a better kind of table, because the table-supporting guides are not subject to any serious wear, but the ram-mounting is worse than that of the pillar style on account of the additional sliding joint of the traversing head.

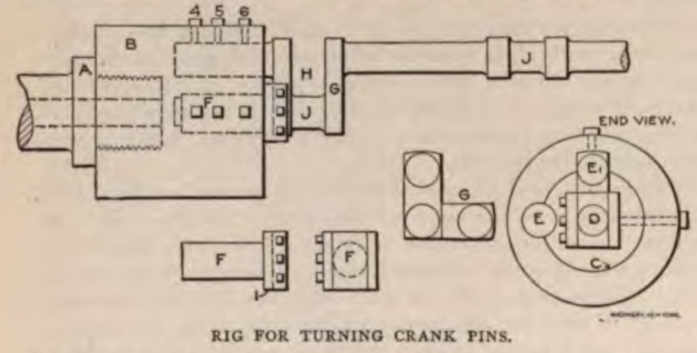
The most radical design and the one which approaches nearest the conditions required for accurate work is the Richards style. In this design there is but one feature which causes difficulty, and that is the feeding of the tool head along the rail, which is always changing its distance from the supporting and guiding ways, hence the tool always springs away from the cut most of all when at the outer end of the rail. The table also springs the most when the tool is in the outer position. This design, however, embodies the right idea of tool-guide construction, and it can be modified so as to do very accurate work and maintain the shape of its wearing surfaces in a superior manner. The sole function of the tool-guiding head should be to carry the tool in a straight line, doing away with the transverse rail feed and retaining only the vertical feed as on the pillar shaper. The table for it should be supported from the base of the frame on a broad horizontal surface and have a transverse feed. With such a design the spring of the tool-carrying head would be a constant amount, no matter what the length of stroke or position of the object being planed. A good point in this design is that the wear on the guides which carry the tool-head could be readily equalized by choosing different locations of the table when the work permitted. Conceding the superior accuracy of such a shaper, the practical question is whether any one would buy it if it were offered. It would undoubtedly cost more to build than the regular kind, and, of course, no one would buy it at a higher price unless a more accurate machine was needed. It would cost less than a small planer, be equally accurate and more convenient to operate. That there would be some demand for such a tool is evidenced by the attempts to improve the regular style. Owing to the cost and the radical departure from standard designs, it would not sell without considerable persuasion, but if once introduced in a shop it would be sure to rank high in competition with other kinds. BELL CRANK.

* * *

## TURNING CRANK SHAFTS.

*Editor* MACHINERY:

Enclosed find sketch of a jig used at the Mare Island Navy Yard for turning plain crank shafts for steam launches (A) is the end of the lathe spindle, on which is nicely fitted the casting (B); (B) is turned and faced and on its end is struck the circle (C) which represents the throw of the crank. The hole (D) is bored exactly 2 inches in diameter and as deep as required. The piece (B) is then carefully chucked and the holes (E) and ($E_1$) are bored respectively 2 inches in diameter and slightly over 2 inches with their centers at right angles and of a proper depth. Two inches is the finished size of shaft, and it is first turned to within 1-16 of finished size. The crank arms (G) are then planed to size and at exactly right angles with the shaft. The space (H) is machined out roughly. Into the hole (D) is nicely fitted the piece (F) which has a square end; this end is planed out in the center down to the dotted lines (I) and made to fit the crank arms. The crank shaft is put into the lathe and fitted to the hole ($E_1$), which is larger than the size finished of the shaft. The casting (B) is screwed on the mandril, the piece (F) put in place and the end of the shaft inserted in the hole ($E_1$) with the crank arms in the slot of piece (F). When this is done, all the set screws are set up and the wrist (J) is turned down near the size. The shaft being reversed and both ends roughed, it is again put into the centers and finished to size, which makes a fit for hole (E) and the casting (B) comes in again for finishing the crank. The back center is not used in turning the crank. This jig does good work and when a number of crank shafts are to be turned it saves a great deal of time and makes them all alike.



RIG FOR TURNING CRANK PINS.

The jig was designed by Mr. W. G. Luper who had charge of the launch engine work. There were a number of launch crank shafts made in the same shop that reflected a great deal of credit on those concerned. The flange coupling on the end of the shaft, two thrust collars, two pairs of forward and back eccentrics (compound engine) and two cranks and air-pump eccentric were all forged in place; the finished size over all being only 26½ inches long.

The ends of the shaft were turned up on the centers and a disk, with all the centers required, fitted to either end. It was a tedious job, requiring a great deal of skill, but Mr. Bruner, the lathe man, did the work right. When the shafts were put in place there was no bother in finding some way to move the different eccentrics one way or the other in order to make the valves divide up in the proper manner. W. DE SANNO.

Kern City, Cal.

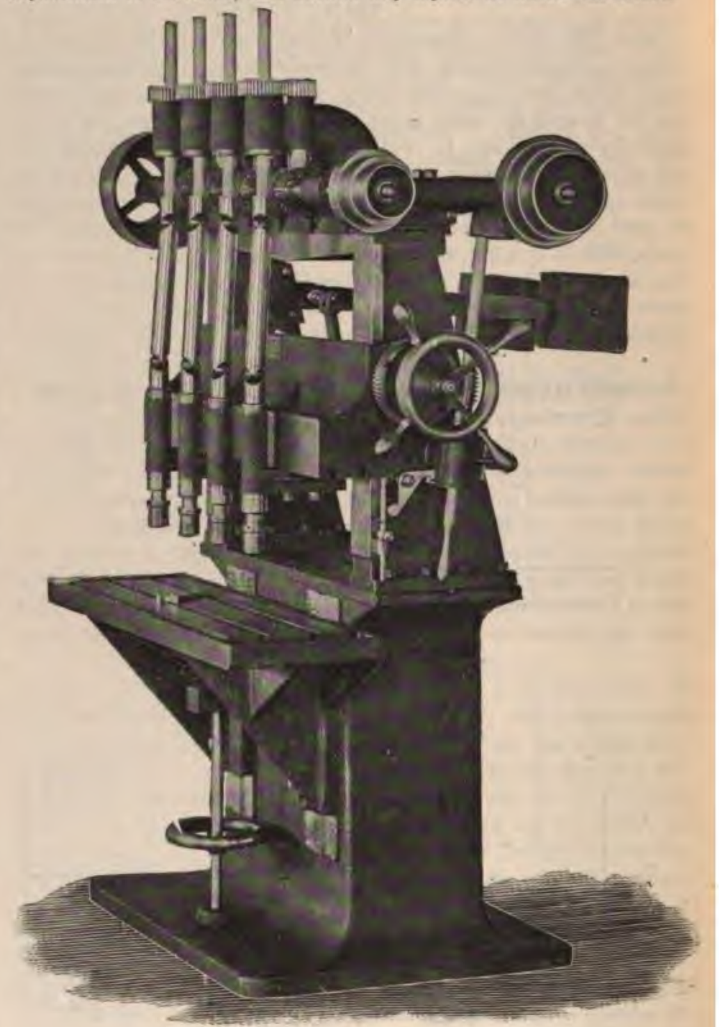
* * *

The ability to harden copper is thought by some to be one of the "lost arts," but it is more probable that instead of hardening the metal the ancients mixed with it a quantity of tin which made it hard and tough enough for their purpose.

* * *

## FOUR-SPINDLE DRILL PRESS.

The accompanying illustration shows a new four-spindle drill press that is now manufactured by Foote, Burt & Co., Cleveland, Ohio. A new feature of the machine is the in-and-out adjustment of the drill spindles, in addition to the longitudinal adjustments. This makes it possible to drill four holes at one setting, in either a straight line or staggered, with any spacing from 2½ inches to 36 inches, center distance. The in-or-out adjustment is 2 inches, and almost any layout of holes can therefore be drilled with this machine. It is provided with power, cross-feed and automatic knock-off, and has three changes of feed and spindle speeds. Quick returns for the spindles are also provided.

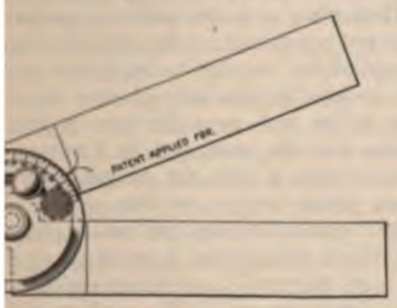


MULTIPLE SPINDLE DRILL PRESS.

The table is adjustable on the column vertically, so as to take various thicknesses of work under the spindles. The spindles are driven by steel bevel wheels having planed teeth, and are geared in the ratio of one to two of driving shaft. The machine will drive four three-quarter inch drills in steel. The table has T-slots and an oil groove around the edge, so that oil can be freely used. Similar machines are also made by this company with from two to ten spindles.

## )RAUGHTSMEN'S ANGLE INDICATOR.

ıeful and novel tool for draughtsmen is shown below,
is made by the Ashland Tool Works, Ashland, Pa. It is
le indicator, consisting of two swivelling blades attached
r swivelling points to a German silver protractor, by
the blades can be set at any angle desired and locked in
position. The instrument can be used as a triangle in connection with the T-square or as a protractor. It is also exceedingly convenient when parallel lines are to be drawn at any other than the standard angles, as, for example, in



g screw threads. The instrument is said by the makers to
ırately made, and the cost is low. As usually made, the
are of celluloid, one inch wide and five inches long.
re also made of nickel-plated steel, with level attachment,
:hanics' use, if desired, and make a convenient tool for the

* * *

## RANKLIN INSTITUTE ANNIVERSARY.

Franklin Institute, Philadelphia, Pa., reached its seventy-
niversary last spring, but its celebration of the event was
d until the time of the Export Exposition, which is now
ıeld at that city. The first of the meetings took place on
y night, October 2, when the chemical section of the
e opened the exercises with an introductory address by
ɪeph W. Richards, the president of the chemical section,
us outlined the policy of the Institute:

aid that chemical science has always been prominently
nted in the Institute's membership. The organizer of the
e. Samuel Vaughan Merrick, was himself a practical
ician, but had as his co-worker William H. Keating,
or of chemistry in the University of Pennsylvania, and
nt out the call for the preliminary meeting. Thus me-
and chemistry conjointly presided at the birth of the
e, fittingly typical of its future sphere of activity.

ssor Keating was appointed Professor of Chemistry as
the Institute was organized. At the annual meeting it
cided to form a section to which all chemical questions
be referred. This principle of the subdivision of the Insti-
ıs so fruitful of results that the example has been fol-
by the organization of four other sections. The creation
was a distinct gain of activity to the Institute, stimu-
ndividual effort in the direction thus specialized, and re-
healthily on the other membership by the general increase
est in the Institute's work.

Institute which so worthily bears the name of Franklin
ays stood for the happy combination of theory and prac-
e union of pure and applied science.

hursday evening, at the session of the mechanical section,
leman Sellers gave an interesting address upon "The
s of the Mechanic Arts in Three-quarters of a Century."
aid that his own lifetime was exactly coincident with that
ocomotive. Previous to the starting of the first railroad
land in 1827, which marked such an era in the commerce
world (it had been in use before in hauling ore and coal
e mines by horse traction), Oliver Evans in Philadelphia
ers had clear perceptions as to the possibility of a steam
engine. The locomotive was then created separately
e railroad, and it was the bringing of the two together,
old by Evans and others, that made the modern railroad
is understood by rapid transit now.

rogress of the mechanical arts depends wholly upon the
es that are making for reproducing machinery; so that
h of the machine tool industry, wholly within the period
s being considered, was of the utmost importance as
ng the rate of progress that could be made.

ellers told a number of anecdotes in the course of his
, among which were the two following, the first of which
o early machine tool work:

He said that when the engine was built for pumping the water at Center Square, Philadelphia, before the Fairmount works were built, the Oliver Evans type of high-pressure engine was used. The cylinder was cast in New Jersey. The boring rod for boring out the cylinder was erected with cutters in it, with levers attached, so that men walking around could propel the cutting tools, and gradually force the rod down through the cylinder until it had been turned out approximately round. After that it had to be filed to a surface. Probably a month was consumed in boring the cylinder. Previous to that fire-engine cylinders had been built in Philadelphia bored out in a similar manner by hand-boring tools. There were no lathes at that time fit for that work, nor was the planing machine then in existence. That came when Dr. Sellers was nearly a grown man. He wished to emphasize the fact that from it sprung all the wonderful advance in machine tool art.

When Oliver Evans gave the makers the size of the boilers to run the Center Square engine—they were plain cylinder boilers—those in charge of the erection deemed that if the length he prescribed was just enough for the requirements it would be well to make them ten feet longer. So they built them ten feet longer, but the boilers would make no steam. Evans was in New York and they sent for him. He returned as speedily as he could by the coaches of that day, and told them they must cut off the ten feet. The fire would not extend far enough back to heat the additional length, and all the steam made on the front end was condensed in the back end. This anecdote shows the general ignorance of the principles of the steam engine at that day.

When the perfection of modern mechanical methods is considered, however, the results obtained in early days should excite our admiration. Fifty years ago the locomotive had a speed record of a mile a minute; the improvements since have been in schedule time and longer runs, rather than changes in the original machine. Skilled Morse telegraphers of to-day can do as rapid work with Morse's original machine.

* * *

## FILLETS AND ROUND CORNERS ON CASTINGS.*

The molder who keeps his eyes open will notice quite a variety of materials worked into fillets on the various patterns he handles, especially if he works in a jobbing foundry. Wood, leather, lead, beeswax and putty comprise the kinds ordinarily used, and they each have their time and place, except the metallic one. A pattern being of wood has a fibrous nature, which will hold glue or any other adhesive substance, while lead has no affinity whatever for glue; so the only thing that can be employed is shellac or nails. I have used yards and yards of lead fillets, so can speak from experience, and I have seen old engine beds and their foundation boxes returned for repairs, where these fillets were fairly stripped away from the pattern; even the small bung-head wire nails used would not keep them anchored down.

Probably the finest fillet of all is made of wood, worked out of the solid pattern, having no feather edges whatever, but this is a very expensive kind, and can only be used on the finest jobs, so in every-day practice we have to add the fillet to the pattern as a separate part.

For fillets from 1" radius down to ⅛", leather is unquestionably the best and most practical material that can be used, and when properly applied will not peel up even with the hardest usage, and requires no nailing whatever, glue being the only agent employed. Those who condemn the leather fillet for patterns, probably do not understand the proper method of applying it. There is a sort of trick about it, to be sure, the key-note of success being hot water. Cover the back of fillet with thick glue, and place it quickly on the pattern. instantly drawing a round-ended slicking tool of proper radius along its surface, bearing down hard to exude any superfluous glue, and following this with a woolen cloth wet in very hot water, to remove all pressed out by the slicker. Repeat this until not a particle of glue squeezes by the edge of the fillet, then wipe with a dry cloth.

This is really not so much of an operation as it may seem from the description and many feet of these fillets can be applied in a very short space of time.

Where it is hard to bind the leather neatly around small curves, etc., just immerse it in hot water, taking it out instantly. This renders it perfectly pliable, but it means quick work, for the thin edges will shrivel and harden at once if not immediately placed in position and burnished down, as previously described. A leather fillet put on properly, with strong glue, can only be removed when dry by main force, and will then come off with fibres of the wood adhering to it, and sometimes the leather itself will keep breaking, it takes so much force to make it let go. Light patterns are strengthened by them to such an extent that nails are frequently unnecessary.

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* From a paper by John M. Richardson, in the Journal of American Foundrymen's Association.

Beeswax is all right for very small fillets, and for finishing out where leather ones come together at the top edge of a rib, when the curve is very small, and for many other places. The wax is prepared by being put in a cylinder, having holes of varying diameter in one end. This is warmed and the wax forced through a plunger, and then applied with a warm slicking tool of the right radius.

If used too cold the fillet will not adhere firmly to the wood. In fact, it is hard to lay wax fillets satisfactorily in a cold room, for both pattern and wax are chilled to commence with, and the heated iron bearing on the top surface of the fillet only makes it difficult to communicate the heat evenly enough through the whole mass to secure a firm contact with the wood, and after the pattern has seen constant use in the foundry, the wax will peel up badly; also it is not a desirable substance for a fillet if sunshine or heat of any kind strikes it to any extent.

Putty has always been used in great quantities in pattern making, and probably always will be, on account of its cheapness. Undoubtedly more feet of fillet can be applied in a given time with this substance, for a given amount, taking both the material and labor into consideration, than with anything else, but it is only adapted to cheap work, and not for standard patterns, as it is soft, easily dented, marred or bruised, besides imparting no element of strength to the work. In some places plaster of paris is added to it to increase its durability, but when this is done, it must be used immediately after mixing.

Black putty is also frequently used. This is nothing but common putty mixed with lampblack, and is employed only on cheap work, having but one coat of shellac, this being applied after the sand-papering, thus comparing in color with the blacking on the pattern, and saving a second coat.

When fillets are called for having a radius above 1", then they must be worked out of wood, and this should be done after gluing to the pattern, not before, in order to have the feather edge adhere as firmly to the work as possible. It is almost impossible not to have the edge curl away if cut out first, and then fastened to the pattern, even if the precaution is taken to have the angle of the fillet made slightly greater than that of the corner it fits, in order to cause a binding of the edges.

A mold of any considerable size can be made more safely, quickly and easily and with a minimum of labor, where these points have been considered in the design, and carefully followed out in the pattern, and with far more chances for a perfect casting, as the danger of cracks in shrinking has been eliminated.

I would go so far as to say that every edge of a pattern, except on surfaces to be machined later, should be rounded, even if the radius of curvature is so small on some light work, that it can be done entirely with sandpaper, and on brackets, ribs, heading, etc., it is much more satisfactory when one gets accustomed to it to have the edges terminate in a semi-circular section, rather than flat with the two corners somewhat rounded.

This rounding of outside surfaces is necessarily on the pattern itself, but there is something else frequently not on the pattern that is expected just as much to be on the casting, and that is, the fillets. How many molders can testify to getting patterns with a chalk mark all around every corner and rib, and this injunction in two words, "cut fillets," also marked in chalk somewhere on the surface. Once in a great while a case occurs where this is justifiable, but it should be rare. A molder does not profess to be a sculptor, and when he is forced to carve out fillets in the sand, who can blame him if, instead of being the radius of a circle they prove to be the hypothenuse of a right-angled triangle. Then, too, there are often places in the mold where it is very difficult to do this, without dropping sand down into parts where it is hard work to remove it, and the result will be an imperfect casting.

The fact of cores coming into the interior of a casting, and the places made by them being entirely out of sight, is sort of a "will-o'-the-wisp" to some, who imagine that fillets are unnecessary because they do not show. This is a great error. They are just as much needed here as elsewhere, to strengthen the casting, and to help resist shrinkage strains, and should be put in of a size proportional to the casting to which they belong, but need not be made excessively large, as they frequently are on the outside of a pattern simply for the graceful effect, for these are not seen. Their place is in the core box, and not as a production of the coremaker's trowel or file. It will sometimes happen that a fillet is called for, on what is the top, or open end of a core box, thus making it impracticable for the pattern maker to provide for it. In such cases the core maker ought not to object to making it in the sand, and, as it comes within the casting, and is out of sight, a plain, flat damper is all that is required, and the fillets already in the core box will be a guide for the size. Another case showing the utility of heavily rounded outlines and fillets on castings is when they undergo the cleaning process, and they will also pickle and peel more freely, as there are no sharp corners for the sand to stick into, and thus time, and the edges of cold chisels, are saved.

As we reach the machine shop, the man who snags the casting finds no sharp corners full of sand to be scraped out with old files, and as he scours his work down with the coarse emery brick preparatory to painting, he can do much more effective service, for as the stone becomes rounded on the corners with use, it will still clean the large fillets, whereas with sharp corners it could not, and finally, when the iron filler is applied to one of these smoothly outlined castings, it can be sand-papered down easily and quickly, so that, after the painting is completed, the effect, when properly done, is almost like velvet.

## LUCIAN SHARPE.

We learn with regret that the senior member of the firm of the Brown & Sharpe Manufacturing Co., Mr. Lucian Sharpe, died at sea while returning from a trip to Germany. The deceased was born March 20, 1830, and was therefore nearly seventy years old. He worked on his father's farm in his youth and received a common school education. Leaving the farm, he served a five years' apprenticeship with Joseph Brown and was admitted to a partnership in 1853. The firm of Brown & Sharpe was incorporated as the Brown & Sharpe Manufacturing Co. in 1868, and Mr. Sharpe has always been actively associated with the business end of the corporation rather than with the mechanical department. A widow, two sons and four daughters comprise the family which survives him.

Mr. Sharpe has left to those who come after him a business that has been conducted on principles of the strictest integrity and that furnishes employment to more than 1,800 men.

The employees at a meeting held Oct. 21 passed resolutions of respect and condolence for his family, and expressed the sense of their own loss in the following words:

"Whereas, Our respected employer and esteemed friend, Mr. Lucian Sharpe, has been removed from among us by death, we, his employees, desire to express our personal sense of loss, our appreciation of his character and our sympathy with his bereaved family.

"We have lost a just employer and a kind friend; this community a distinguished citizen, a wise counsellor, a true gentleman and an honest man.

"We appreciate the strength and nobility of his character, his kindly spirit, his scrupulous integrity and his profound common sense. In the management of his business he was himself as prompt and attentive to details as he would wish others to be, and his acts and influence tended to elevate his employees. His effort to express exact truth in every production will remain with us as a worthy example and perpetual inspiration.

"We extend our heartfelt sympathy to his bereaved family, and shall ever aim to show it by that faithfulness in our several positions which so thoroughly characterized him in all the relations of his life."

Oscar J. Beale.
Willard T. Hatch.
Alpheus L. Greene.
L. D. Burlingame.
D. D. Donovan.

## PIPE BENDING.

R. H. PERRY.

The iron piping of an ordinary steam plant does not usually afford many examples of turns and offsets made by long bends in the pipe, but changes in direction are almost invariably effected by the use of pipe fittings of the required angles. The reason for this state of affairs is not difficult to understand, for, although it is generally understood that the less abrupt the change in direction of the flow of any medium, the less the losses from friction, yet the difficulty in making satisfactory bends in pipe much larger than 1½ inches is generally enough to discourage any refinements of this description. The piping of railway rolling stock, however, is subjected to such severe usage that every expedient is adopted in the best practice that will reduce leakage and maintain the integrity of the pipe lines, especially in the train pipes for the air brakes.

The consequence is that pipe fittings for changing the direction of any pipe, either on the locomotives or cars, are avoided whenever it is possible to bend the pipes and get them into position when bent. Many of the pipes on a locomotive are therefore so crooked that they will scarcely lie still when laid on the floor, and to be obliged to duplicate such an example of pipe bending is enough to strike terror to the heart of a pipe-fitter not accustomed to such work.

The proper bending of the larger sizes of pipe is a distinct branch of pipe-fitting which is rapidly coming to the front, especially in plants that are making extensive installations of pneumatic tools, as it has been found that the losses that occur in pipe lines put up in the usual slipshod manner are enough to warrant the extra expense of long bends instead of the ordinary fittings. It is thought that in view of these conditions a few pointers calculated to assist in making difficult bends will be appreciated by those likely to encounter work of such description.

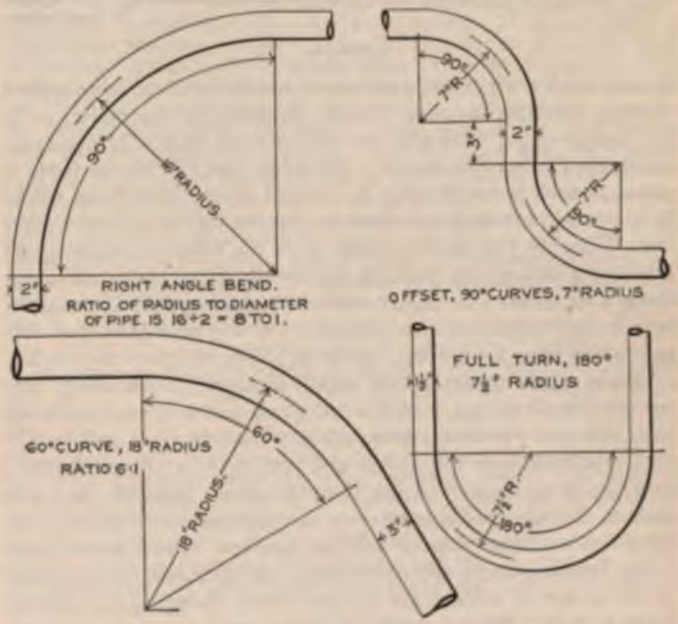
Of course, where large numbers of pipes are to be bent to the same radius it pays to expend considerable time and money on formers and apparatus for the work, but where the pipes are bent for a special job and to a variety of radii, it does not usually pay to prepare anything of the sort; so in the following it will be assumed that nothing is provided for the work that will not be found in any ordinary shop.

The most practicable method under such circumstances is to fill the pipe to be bent with perfectly dry sand and plug or cap the ends so that the filling will be retained under quite severe handling. Care should be taken to have the pipe well filled with the sand and that there is nothing inflammable or damp in it, as the necessary heating of large pipes is very likely to cause a serious explosion. The heating of the pipe may be done in an ordinary forge, and should be restricted to the part of the pipe that is required for the bend; also overheating should be avoided, as the loss from scaling has a very appreciable effect on the bursting strength. The best results will be obtained when the heat is not carried above a full red, as the liability to kinking is less, and in any case it is usually necessary to heat two or three times before a sharp bend can be satisfactorily made, so that nothing is gained by heating to a high temperature. A can of water should be provided, which should have a spout so that a small stream can be directed exactly where needed, as its proper use plays an important part in securing bends without kinks, a point which is highly desirable, as a kink is always an eyesore in the appearance of a pipe, besides seriously reducing its capacity at that point.

After the pipe has been heated to the proper temperature, it is clamped in the vise as close to the location of the bend as possible without grasping the red hot part and the bend started, but first the outside of the curve should be cooled with water carefully applied from the can. The inside of the bend being hot and plastic is compressed as the bend is made with very little tendency towards flattening, but if such a tendency develops, it can be corrected by loosening the pipe and using the jaws of the vise to bring the flattened part back to an approximately circular section. The reason for applying the water to the outside of the curve is that by forcing the bend to take place on the inside of the curve, the pipe walls are better supported by the filling, for the reason that the cubic contents are slightly reduced by the compression; whereas if the exterior of the curve be allowed to stretch, the cubic contents are slightly increased, which allows a small amount of slackness in the filling at that point and a consequent lack of support to the interior of the pipe. The use of water also plays an important part in the proper formation of the curve, as by its use the pipe may be cooled at a point where the required curvature has been obtained and still leave the remainder in a condition to be bent as desired. When bending pipe without formers it is necessary to have a template, which may be made from a ¼-inch rod bent to the desired curve and which, being laid on the pipe while bending, gives a guide for the operator. The use of water for cooling the outside of the curve can usually be dispensed with when the radius equals or exceeds fifteen times the diameter of the pipe.

When bending the cheaper grades of butt-welded iron pipe care should be taken that the seam comes on the inside or the outside of the curve and not on the sides, as it is much more likely to crack open in the latter position. While considerable experience is required before the best results can be obtained in hot pipe bending, the method to be pursued is simple when it is understood—a condition which, however, is equally true of many other things.

When piping or thin tubing is to be bent and it is necessary to avoid heating on account of the finish or other reasons, it is customary to use a filling that can be melted at a low temperature, such as rosin for copper or a metal alloy for iron or steel pipes. As these alloys are made that will fuse at or slightly above the boiling point of water, their use is feasible on small pipes, but scarcely so on the larger ones, as the immense amount of metal required, together with the inevitable losses from melting and filling, is a serious expense.



SOME SAMPLES OF PIPE BENDING SHOWING THE RELATION OF THE DIAMETER TO THE RADIUS.

A simpler method which has been recommended for cold bending is the use of a coil of closely wound steel wire of a diameter slightly smaller than the interior of the pipe to be bent. Good results are obtained where the curves are of a moderately long radius and where the bend is not of sufficient angularity to prevent the removal of the coil after the bend has been made. This difficulty can be helped by tapering the coil to which the chain or cord is attached to a smaller diameter than the main part, so that when the tension is applied the turns of wire successively reduce in size until the whole coil can be removed. The use of bends in piping will usually necessitate the use of unions or right and left couplings, both of which are somewhat more likely to leak than the ordinary right-hand coupling, but when properly put together there should be no trouble in this direction, and, besides, such a construction possesses an advantage in being much easier taken down for repairs or change than the ordinary system.

The time is, therefore, not far distant, let us trust, when the piping of our modern plants will be characterized by the absence of unnecessary right-angle pipe fittings and the presence of graceful curves that satisfy both the eye and the instincts of the mechanical engineer.

## HOW AND WHY.

### A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

**Give all details and name and address. The latter are for our own convenience and will not be published.**

10.—M. P. B.: I have seen a man set the tail stock of his lathe over and turn a piece taper at one trial, without any filing, so that it would fit a taper hole. Please tell me how to set over the center so as to do this.

A.—We think, in the first place, that if your friend had rubbed a thin coating of Prussian blue on the taper piece and then fitted the two together he would have found by noting where the blue had rubbed off that he did not have a close fit the whole length; or, if he did, it could have been only by chance, for, unless some very unusual precautions are taken, such as would not be used in every-day work, it is not possible to obtain so accurate a taper by setting over the head stock without one or two trials. In turning tapers it is best to determine before starting what the large and small diameters of the taper are to be. Suppose, for example, that you have to turn a Morse taper shank on a piece like Fig. 1. We know that the Morse taper is about ⅝ inch per foot—that is, a taper piece 1 foot long would be about ⅝ inch larger in diameter at one end than at the other end. Suppose you have a socket to fit the taper to and that you find it is 4 inches long and that the mouth of the socket measures about 1.25 inches. Since the taper is ⅝ inch per foot, the taper in 4 inches would be 4-12 × ⅝ = 1-3 × .625 = .2 inch, and this subtracted from 1.25 inches, the large diameter, gives 1.05 inches, or about 1 3-64 inches as the small diameter. Now center and lay out the piece, put it in the lathe and scribe a mark 4 inches from one end. With a cutting-off tool neck in at A until it calipers 1-32 inch over 1¼ inches and turn down at B until it calipers the same amount larger than the small diameter, or 1 5-64 inches. Finally, put a pointer in the tool post and set over the tail stock until the pointer will just touch at A and B, the work being removed from the centers and the carriage moved along to so as not to disturb the pointer when changing its position from A to B. When turning the taper set the tool exactly on a level with the centers. Rough out the piece and try it in the socket. This will show how near you have hit the taper, and with one or two trials you should be able to finish the piece.

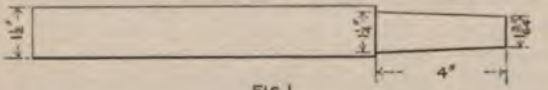


FIG. 1

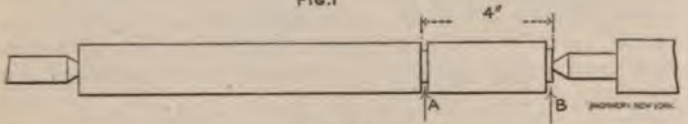


FIG. 2.

11.—A. C. H.: Please tell me what book you think would be the most useful for a man wanting information about gas engines and their design.

A.—The series of articles upon the gas engine, commencing in this issue of the paper, will cover gas-engine design in a simple and comprehensive manner. The work by D. Clerk, "The Gas and Oil Engine," published by John Wiley & Sons, New York, is generally regarded as the most complete general treatise upon the gas engine. The price is $4. Another good book, though a smaller one, is "Modern Gas and Oil Engines," by Grover, for sale by D. Van Nostrand; price, $2. This book contains a chapter upon the design of gas engines, with the necessary calculations worked out. If one wishes a description of many different types of engines merely, with only a brief explanation of the theory, "Gas, Gasoline and Oil Engines," by Hiscox, published by Norman W. Henley (price, $2.50), may prove serviceable.

12.—A. H.: 1. What size engine would be required to run a boat 40 feet long, 7 feet beam, of a good model, 12 knots an hour? 2. What should be the proportions for a compound engine for such a boat, revolutions 225 and boiler pressure 300 pounds? 3. What is the best make of boiler to use? 4. What would be the best form of propeller? 5. Please give me the names of manufacturers of castings for such an engine.

A.—1. Assuming that the draught of your boat is about 2 feet, it would require 45 horse-power. If you were content to attain a speed of 10 knots, 25 horse-power would answer. 2. We do not like the pressure and number of revolutions that you propose to use. A boiler pressure of 300 pounds will give a very high mean effective pressure in the cylinder, meaning that cylinders of small diameters can be used. On the other hand, the number of revolutions is not high enough to give a piston speed of 700 or 800 feet per minute, as it should for best economy, without making the length of cylinder entirely out of proportion to its diameter. We would suggest that you adopt 150 pounds pressure, and increase the number of revolutions to 400. There is no economy in such high pressures for small engines. When you decide definitely upon these points we shall be happy to help you with the proportions of the engine; or, better, can refer you to "Compound Engines," by James Tribe, Racine, Wis. (price, $1.50), from which book you can learn to make your own calculations. 3. The Almy water tube boiler, made at Providence, R. I., is one of the best. 4. Use a four-bladed propeller. Read the article upon "Steam Power of Small Yachts" in the April number of this paper. It was written to hit just such cases as yours. 5. We think there are no castings made that are for sale as large as you will require.

13.—Apprentice: 1. As I understand it, it is because of the presence of carbon that tool steel hardens on being immersed in water after being heated. Why does not machine steel, which possesses some carbon, harden on being heated and cooled? 2. Also, why does not cast iron harden, since it possesses quite a percentage of carbon in combination? 3. Every blacksmith knows that steel, if overheated, will "burn" and become useless. How is it possible, then, to melt steel in the open air and run it into molds, to be called cast steel?

A.—1. You are quite right in your supposition about the effect of carbon in steel. Just why this is so we cannot tell, and we are not sure that chemists are fully agreed upon the subject either. Experience shows that steel with .25 per cent. of carbon will toughen somewhat when heated and immersed in water. Below this point the effect is not noticeable, and, as machine steels seldom are as high in carbon as this, they will not harden. 2. The ordinary gray cast iron contains a large percentage of carbon, usually 3 or 4 per cent.; but only a very small proportion of this is combined. One analysis which we have shows only .04 per cent. of combined carbon, which disposes of the question of hardening, so far as gray iron is concerned. White cast iron, on the other hand, contains nearly all of its carbon combined, and, as you know, it is often very hard. Chilled iron is essentially hardened iron, and is often hard enough so that it is used for cutting tools. In order to harden, or chill, it, however, it must first be heated to a temperature high enough to melt it, in which respect it differs from steel. 3. When a blacksmith "burns" steel, he partially melts the steel, and the heat of his fire is so intense that the steel becomes decarbonized to a greater or less extent. This is exactly what would happen when cast steel is made, were it not for the fact that the metal is heated with ores which contain sufficient carbon to make the final mixture of the molten metal have just the proportion of carbon desired.

14.—B. E. S.: 1. Please tell me the proper way to grind drills for brass, iron and steel. 2. Should the countershaft of a lathe be placed directly over it or at the back, and if the latter, is 45 or 30 degrees the proper angle? Also, how far above the lathe should the countershaft be placed?

A.—1. In grinding drills the two lips should be of the same angle and length, as otherwise the drill will crowd to one side. The angle of lip clearance should be greater at the center than at the ends of the lips, but it must not be excessive, as it will cause the drill to "bite." The angle of the lip to the axis of the drill should be 60 degrees, as this angle will give a straight cutting edge. We should grind the same for iron or steel, but for brass or other soft metals you may have better results if the lips of the drill are flattened from 1-32 to 1-16 of an inch in a plane parallel to the axis of the drill. This prevents the drill from catching when breaking through at the bottom of the hole. The Standard Tool Company, Cleveland, Ohio, makes a neat twist drill gauge that is of assistance in grinding drills. 2. The countershaft should be placed slightly back of the lathe, and we should prefer at an angle not to exceed 30 degrees. For a shaft of ordinary height the countershaft should be placed perhaps two feet back of the lathe. While an inclined belt of considerable length has greater driving power than a short vertical one, the chief point to consider in putting up countershafts is the convenience of the workman in shifting his belts, provided there is nothing to make it necessary to place the countershafts elsewhere. If you have unlimited head room, we should place the countershafts at as great a height as you find upon experiment you can easily shift the belt from one step of the cone to the next one.

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15.—A. W. P.: 1. Please give me the taper for lathe spindle bearings as usually considered the best practice in the United States. 2. What do you consider to be suitable speeds for metal working?

A.—1. It is not the usual practice, nor is it considered the best practice, in this country to taper the spindle bearings of lathes. The best we could do, therefore, would be to refer you to proportions given in English works upon machine design, which you probably already have at your disposal for reference. 2. The following cutting speeds probably represent average practice: Cast iron, 20 to 30 feet per minute; wrought iron, 25 to 30 feet; machine steel, 25 to 35 feet; tool steel, 12 to 15 feet. These figures may often be widely departed from, however. Cast iron may be so hard that it is almost impossible to cut it at all, and, on the other hand, if particular attention be paid to its composition in the foundry, it may be soft enough to cut at a very high rate of speed. In shops in this country where this is done it is quite common to cut cast iron at the rate of 40 feet per minute. Again, the same things are true of steel. High carbon steel may have to be cut at a very low rate, and we have known of soft machinery steel being cut at the rate of 100 feet per minute. The speed must necessarily depend, also, upon the size of cut taken and whether the tool is flooded with oil or soda water, as is done in many shops, and always on screw machines, where a cutting rate of 40 or 50 feet is not uncommon.

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16.—C. G. P.: Please inform me whether a cemented or a laced joint is the better for belts, and which is the stronger and how much stronger. 2. What is the best way to make a cemented joint?

A.—1. Barring the fact that it is not easy to take up the slack in a cemented belt, such a belt is better than the laced one. A good cemented joint should have nearly or quite the full strength of the belt. It would be safe to consider a laced joint as having one-third the strength of a cemented one. To make a cemented joint a belt clamp must be used to hold the ends in position. Shave off the ends on a bevel to a distance of about one and a half times the width of the belt, shaving the leather from the inside of one end and the outside of the other. Now coat the surfaces thoroughly with fish glue and clamp together. To hold firmly in position, peg together with a few shoemaker's wooden pegs. A good deal of skill is required to make a solid joint, and it will not have the desired strength, of course, unless it is well done. From some dealer in belting you may be able to procure a water-proof cement if desired.

* * *

We are constantly being reminded of the wonderful things that are accomplished by the aid of electricity, as for example, the following item, clipped from a recent issue of an electrical paper, will show:

"Sculptors are now said to be doing much of the mechanical part of their craft by means of an electrical carver. The actuating power of the device is derived from a small electric motor and pump, which, standing on the scaffold, supply air at a pressure of fifty pounds to the square inch. In his right hand the carver holds a steel cylinder, to which the compressed air is conveyed by rubber tubes; the other hand holds the chisel, which fits loosely into a socket at the end of the cylinder. Within the barrel of the cylinder is a solid piece of steel with hardened, bullet-shaped head. Under the pressure of the air this strikes the end of the chisel, rebounding and restriking with a varying rapidity of from 4,000 to 5,000 blows a minute."

It must require quite a stretch of imagination to be able to designate a compressed air appliance as an electrical tool, simply on account of the air supply being furnished by an electric motor. It would be equally as sensible to call the sculptor's tool a hydraulic carver if it should occur that the compressed air were supplied by a water motor.

The Dewey celebration in New York City was, of course, immensely profitable for the local traction companies, and all of them broke their previous records of numbers carried. The "Electrical Review" is responsible for the following figures, which, if they could be grasped, would give somewhat of an idea of the magnitude of the crowds that came to welcome the victorious Admiral: "On September 28 the Metropolitan Street Railway Company carried 1,119,000 cash passengers, or 215,000 more passengers than the system had ever before handled in one day. On the following day it handled 1,304,380 persons, and on Saturday 1,019,440. On October 1 the road carried 711,480 people. On the Third avenue line the increase of passenger traffic for September 28, 29 and 30 was 572,000. The receipts of the Brooklyn Rapid Transit Company for September 29 and 30 were close to $75,000.

* * *

## FRESH FROM THE PRESS.

Heat and Heat Engines, by Frederick Remsen Hutton, E. M., Ph.D., Professor of Mechanical Engineering, Columbia University. Published by John Wiley & Son, New York. 540 8vo pages, illustrated.

This book gives a practical treatment of a theoretical subject and will prove a useful handbook for the engineer in practice. It tells in a clear manner how to make the calculations most often met with in connection with the different forms of apparatus that depend upon heat for their action. It is essentially a treatise on thermodynamics, although broader in its scope than this term implies, and it differs from other works in that the higher mathematics are not used. The book is not in any sense an elementary work, but the author asks the reader to accept the results deduced by the higher mathematics and then shows how they are applied in practice. It is believed that the student will secure a firmer grasp of the subject when he is able to get at the practical applications from the start than where he is compelled to first plow through intricate mathematical demonstrations, the utility of which he cannot at once appreciate. The book contains the material that is given the students in mechanical engineering at Columbia University in connection with "The Mechanical Engineering of Power Plants" by the same author, which has previously been mentioned in these columns. It will also prove of use to men engaged in engineering work.

The various subjects follow in logical order from the generation of heat in the furnace to the design of the cylinder that is to utilize the heat energy of the steam or other heat medium. The chapters on fuel, pyrometers, draft and heating surface introduce subjects generally found only in books on steam boilers; but their grouping with the other subjects makes the work a complete reference book of the general principles underlying the generation of power from heat. Besides the steam engine, the air compressor and compressed air engine, the gas and oil engine, the vapor engine, refrigeration and the injector are given full treatments. The essential facts regarding gases and vapors are also discussed.

At the present time the books by Peabody and Ewing are perhaps the best known modern authorities upon the subjects mentioned above, but their treatment is so mathematical that the general reader would probably think them unavailable for his use. Prof. Hutton has prepared a work of the same grade and has done a real service by treating the subjects in such a manner that they can be readily approached without a knowledge of the calculus. After mastering its contents the student may then find his appetite sufficiently whetted to investigate the intricacies of other works.

We think it would have been appreciated if the author had added a chapter on the results of tests upon apparatus treated so that the student would have more definite information on which to build. It seems to be quite as essential to have this information in questions pertaining to heat as in the strength of materials.

## ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9 x 12, 6 x 9 AND 3½ x 6 INCHES.
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TO BE PRESERVED.

Weston Manufacturing Co., Springfield, O.—Catalogue of lathe, planer, and shaper tools—18 6x9 pages illustrated.

A variety of tool holders are made by this company for boring, turning, threading, planing, etc., and the line which they have to offer appears to cover the field very thoroughly. A number of the holders are quite novel in design.

The D. Van Nostrand Co., Publishers, Murray street, N. Y., have now ready an eighty-page alphabetical and classified catalogue of electrical books. It is arranged by subjects and authors, and will be sent free upon application.

We have received from the Joseph Dixon Co., Jersey City, N. J., an interesting pamphlet setting forth the advantages of flake graphite for use in steam engine cylinders, together with a description of the necessary appliances for introducing the graphite in the cylinder. We would suggest to engineers that they write for this pamphlet, as it will be of value to them.

Brown & Sharpe Manufacturing Co.—Catalogue of machinists' and measuring tools, 150 6x9 pages illustrated.

This is a new catalogue that will be of interest to machinists who are always anxious to keep informed upon new tools as they are put upon the market. There are new illustrations of the older tools which show them much more clearly than before and it has been the aim to give as complete and full information as possible throughout. Among the new tools that we note are some new styles of steel scales, micrometer calipers for measuring up to 6 inches, inside micrometers, a height gauge, a new surface gauge, and there is also shown a photographic reproduction of the Brown & Sharpe measuring machine which measures to point 00001.

The Standard Tool Co. have issued a small pocket manual of 24 pages that contains data of value to mechanics and also illustrates some of the tools made by this company.

The Safety Emery Wheel Co., Springfield, O.—Catalogue of emery wheels and grinding machinery, 80 6x9 pages illustrated.

A full line of emery wheels is listed in this catalogue all of which have an annular shoulder near the wheel over which a collar fits and thus prevents serious results in case the emery wheel bursts. A complete line of grinding and polishing machinery is shown and there are a number of technical points given in the catalogue for the uses of these appliances.

One of the handsomest and most elaborate catalogues that has been received at this office is one that is issued by W. S. Laycock, Sheffield, England. It relates to railway carriage fittings and steamship specialties and is illustrated with beautifully executed half-tone engravings.

## MANUFACTURERS' NOTES.

The Standard Pneumatic Tool Co., Chicago, Ill., advise us that their mechanical superintendent, Mr. Henry Kimman, will superintend the installation of machinery in the works of the International Pneumatic Tool Co., Chippenham, England, which company recently purchased the right to manufacture and sell the Little Giant Pneumatic tools in the British Empire. He will later make a tour of inspection throughout Europe.

The Tanite Co., of Stroudsburg, Pa., is building a new and improved Emery Planer for the Altoona shops of the Pennsylvania Railroad Co. This machine will be the largest of the kind yet built, weighing in the neighborhood of a ton and a half.

The Trade Paper Advertising Agency will soon open a branch office in Philadelphia for the convenience of its clients in that district, which will be in charge of Mr. S. A. Elkington, who has recently become connected with this firm.

The Cling-Surface Co. send us the following copy of a letter received from Prof. Carpenter under date of October 5: "Later tests of the use of Cling-Surface on belting substantiate in every particular the statements made in my report of April 17. They also indicate higher efficiency of transmission and less loss of power in the case of belts treated with Cling-Surface than in the case of belts not so treated, when working under the conditions prevailing at the time of the earlier test. This is due to the fact that the slipping of a belt causes considerable loss of power, the power so lost passing off in heat. The use of Cling-Surface reduces the slipping and consequently reduces the loss of power occasioned by the use of belts that slip. During the past six months I have had occasion to observe the practical use of Cling-Surface in a number of instances. In all such cases Cling-Surface has improved the belts by softening them, and as far as I can determine in the limited time (seven months) tends to preserve the leather of which they are constructed."

Rawhide, fibre and hard rubber gears. THE ARTHUR Co. (See page 41.)

FOR SALE.—One of the best located jobbing foundry and machine shops in the Mississippi valley. Good trade established. Satisfactory reasons for selling. Address Box 554, Galesburg, Ill.

WANTED.—Second-handed wood, iron and bronze working machinery, first-class condition, at very low price cash. Can use complete factory outfits. Itemize and describe machinery for sale, giving condition, age, name and address of manufacturer, attachments, etc., and lowest price at which each machine will be sold. Address "MACHINERY," P. O. Box 528, Chicago, Ill.

FOR SALE.—Arthur Herschmann's Hydraulic Clutch. Manufactured under license in Austria by Messrs. Actiengesellschaft für Maschinenbau Brünn; in Great Britain by Messrs. Alldays & Onions, Limited, Birmingham.

Automatic and only positive acting clutch in which engaging and disengaging force are alike, the second being the reaction of the first. American patent will be issued October 24. For license or purchase of patent address,

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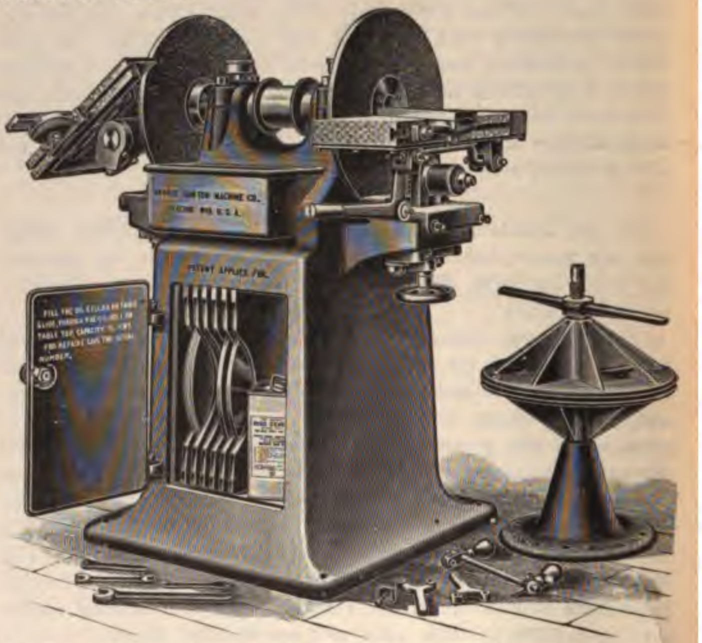

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MACHINERY.

Vol. 6. December, 1899. No. 4.

# COMPRESSED AIR IN THE SHOP.

## DESCRIPTIONS OF AIR COMPRESSORS AND COMPRESSED AIR APPLIANCES.

THE various uses to which compressed air is being put in all industries show conclusively that it is an agent of the greatest value for the transmission of power and the performance of certain other functions that come peculiarly within its field. A list of the various uses to which air under pressure is being put, published in the catalogue of one of the leading makers of compressed-air appliances, contains nearly two hundred distinct operations, and there is little doubt that the list could be nearly doubled if the trouble were taken to thoroughly investigate the industrial field. It may be mentioned that the uses of compressed air range from whitewashing to the raising of sunken vessels, but its use for fanning forge fires is undoubtedly the most ancient application in the industrial arts and the one with which the inhabitants of all countries are most familiar.

While its use in the machine shop is by no means a recent innovation, the practical use of compressed air in many shops for the operation of hoists, presses, pneumatic hammers and other shop tools has taken place within a few years. Strange as it may appear, the railroad shops have been the leaders in the use of compressed-air appliances and must be given credit for many novel and ingenious applications well calculated to reduce shop expenses. The reason for this condition of affairs is not difficult to discover as railroad men have had in recent years a practical example of the powers and possibilities of compressed air in the Westinghouse air-brake apparatus. With a number of the Westinghouse air pumps always in the shop, it is not strange that they should have been utilized for shop purposes when so easily set up and operated and naturally one use has suggested another.

Electricity, compressed air and water under pressure are the three mediums for the transmission of power that stand preeminent and each has its field of usefulness which cannot well be filled by either of the others. The most earnest advocate of electrical transmission cannot but admit that compressed air is peculiarly adapted to the operation of such tools as the reciprocating hammer for chipping or riveting, and on the other hand electricity is far superior for the operation of traveling cranes on account of the general flexibility and simplicity of the connections. For the working of presses that are to be operated by fluid pressure and which require a heavy pressure per unit of piston area, the hydraulic system is easily the best as the incompressibility of the water makes a rigid and inflexible medium which is always under instant control and which makes possible an enormous multiplication of pressure in a very simple apparatus. For the operation of an ordinary shop hoist, compressed air is superior to water under pressure in many ways and will usually equal it in economy. Although an air hoist is a wasteful apparatus when working to its full capacity on account of the liberation of the contents of the cylinder under initial pressure it will compare well with the average operation of the hydraulic apparatus. The water hoist for a certain lift always uses the same quantity of water regardless of the weight lifted and the power represented is the weight of the water multiplied by the head in feet. So if a small article be raised by a hydraulic hoist, an amount of power is wasted that is expressed by the difference between the weight of the piece and the weight of the water multiplied by its head. On the other hand the pneumatic hoist needs only enough pressure on the piston to balance the weight to be lifted and the pressure per unit of area may be only a fraction of a pound per square inch. A hoist for any given position is naturally made of sufficient size to raise any piece that is likely to be handled, so it usually is considerably larger than the most of the work requires and as a hydraulic hoist can be superior to the pneumatic form only when the load approaches or equals the limit of its capacity, it appears that the latter is superior in economy when the average of the lifts is taken. The practical advantages of being free from drippings, freezing and other defects inseparable from the hydraulic system makes the pneumatic type incomparably superior for all ordinary uses.

The economical production of compressed air has in recent years attracted the attention of the best mechanical engineers and the problem is found to be far from simple, being as complex in many respects as that encountered in the steam engine. In the steam engine the constant endeavor is to preserve the heat of the steam and to reduce the losses from condensation. This is effected by jacketing and multiple cylinders which reduce the expansion in each unit to that which is found to be most favorable for economy. On account of the storage of compressed air in receivers and pipes, where it must cool down to temperature of the atmosphere, it is poor practice in air compression to expend energy to be wasted in the receiver; so the effort in all the best compressors is to cool the air during compression and lessen the loss from this source. When air is compressed in a non-conducting cylinder, its temperature increases with the increase of pressure. An indicator card taken under these circumstances will show the compression to be adiabatic, whereas the best economy demands that the curve should be isothermal or approach it as nearly as possible. If the compressed air were to be used immediately after compression before it had time to cool, isothermal compression would entail an unnecessary loss, but under ordinary circumstances cooling devices are necessary both for economical production and for mechanical reasons as the heat developed in a compressor working rapidly and under heavy pressures would cause serious trouble if not the destruction of the machine. The best practice requires that the work of compression be done in stages, and we thus find the air compressor the same as the steam engine passes from the simple machine of one piston and cylinder to the double, triple and quadruple compressors which raise the pressure by steps and reduce the heat of compression in inter-coolers. Water jacketing alone in high pressure machines is not sufficient to accomplish the fullest cooling effect as the time the air is in contact with the walls of the cylinder is so short that the cooling is limited to a thin layer which is small when compared to the total capacity of the cylinder.

Cooling by an injection of a spray of water in the cylinder has fallen from general favor on account of the difficulties encountered with the water that is taken up by the air and deposited in the pipes as it cools. The best results in air motors and similar tools are obtained when the air is dry, as moisture always proves troublesome from the freezing in the exhaust ports, being often sufficient to choke them entirely. It therefore follows that the cooler the air supply is before compression the less the trouble from moisture, as the capacity of air for moisture diminishes with a decrease in temperature so that less moisture will be carried in cold air than that having a higher temperature when both have been exposed to ordinary atmospheric conditions. Another advantage that comes from the cool air supply is that the efficiency of the compressor is increased by about 1 per cent. for each 5 degrees decrease in temperature, which makes it clear that the air supply for a compressor should always be taken from some source besides a hot engine room, as is so often the practice with shop installations.

### Compressors for Air-brake Service.

We show in Fig. 18 the Westinghouse compressor or air pump that is generally used on locomotives for the air-brake apparatus, probably compressing more air per day than all other compressors combined, and as intimated before it is used to some extent in railroad shops for a shop compressor. By reason of its construction it necessarily cannot be an economical machine and is not recommended for shop use, being designed entirely for railroad service where economy as compared to reliability is a secondary consideration. In Fig. 19, the air pump manufactured by the New York Air Brake Company is shown in section. This machine is a duplex compressor, the air being compressed in the larger cylinder first and then passing through the smaller one. By reason of the service for which these compressors are designed, no provision is made for cylinder cooling except a recently adopted ribbed construction in the Westinghouse pump, which thus presents a greater area to the atmosphere. Either of these pumps makes a cheap and reliable compressor for shop use where but little free air is to be compressed and where the question of economy is of a secondary nature. It is but fair to state that the duplex form of the New York Air Brake Company will compress air more economically than the simple form using the direct pressure of the steam piston without the intervention of revolving parts.

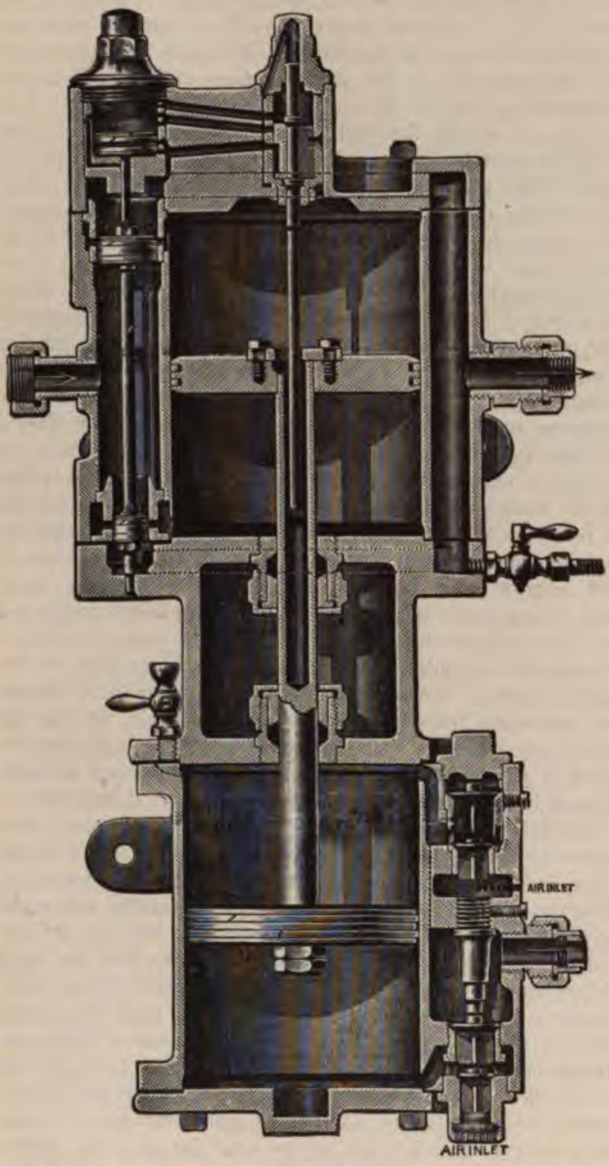

FIG. 18. WESTINGHOUSE AIR BRAKE COMPANY'S PUMP.

### Steam Actuated Compressors.

In Fig. 2 on pages 112 and 113 is shown an Ingersoll-Sergeant duplex steam actuated compressor of about 125 H. P. which has a capacity of 1900 cubic feet of air per minute. This compressor has the Meyer adjustable cut-off valve for the steam engine and the hollow pistod-rod inlet for the air cylinders. The latter is shown in detail by Fig. 20 and as will be seen the free air is drawn into the cylinder through the hollow piston rod and piston. The inlet valves are located in the piston and of course travel with it throughout the stroke. The valves are indicated by G G and are of ring form. Dowels located at intervals around the piston hold the valves within the limits of the slotted holes through which they pass. By this form of construction no springs are required to seat the valves as they automatically open and close with the reversal of the piston movement. The piston clearance in this form of compressor is reduced to a minimum, there being no countersunk spaces in either the piston or cylinder heads and by the peculiar construction of the inlet valves, the clearance space about them is very small. Two advantages are claimed by the manufactures for the hollow piston and piston rod. The cool air passing through the piston keeps its temperature low so that it is more fit mechanically for its work and again the flow of air is not interrupted but passes through the hollow piston rod in a practically uninterrupted stream. From this construction and that of the inlet valves being without springs, a gain of from 5 to 10 per cent. is claimed over a construction which involves the starting and stopping of a column of air at the end of each stroke. This company also makes a feature of small compressors for pressures up to one hundred pounds per square inch which represents the average shop practice.

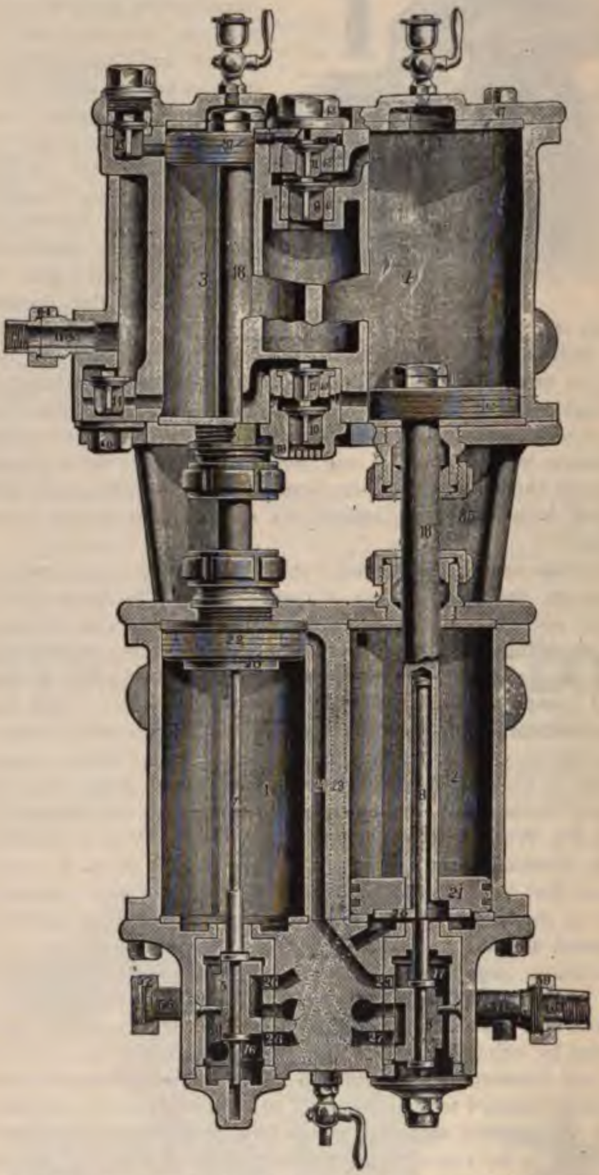

FIG. 19. NEW YORK AIR BRAKE COMPANY'S DUPLEX PUMP.

The steam-actuated Clayton compressor has a peculiar connecting-rod arrangement by which compactness of construction is obtained and the location of the crank shaft kept in the line joining the two cylinders. This is accomplished by connecting the steam and air cylinders by a yoke arrangement which passes above and below the shaft and gives room for the connecting rod and crank between the two members. By this construction, steadiness of action by reason of the revolving parts is obtained and also the compactness of the ordinary direct-acting steam pump. The larger sizes of these compressors are built with Corliss cross-compound steam cylinders when so ordered.

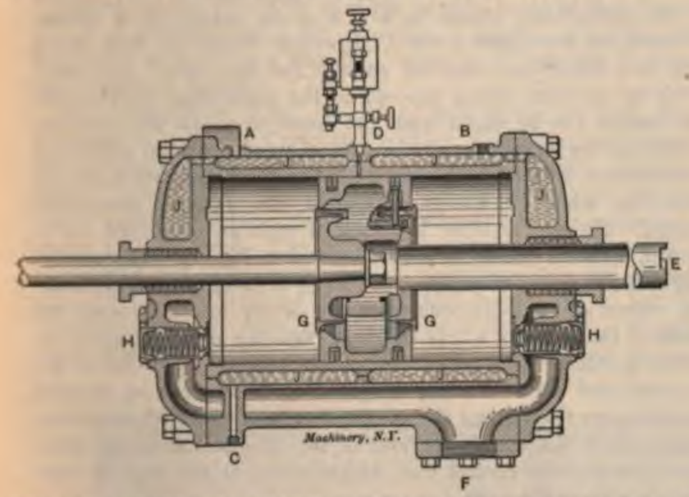

FIG. 20. SECTION OF INGERSOLL-SERGEANT COMPRESSOR CYLINDER.

The illustrations shown in Fig. 21 and Fig. 22 are the Norwalk standard form of compressor and an upright form intended for shop use. The standard compressor built by this well-known company is provided with mechanically-operated inlet and exhaust valves of the Corliss type. The objection to mechanically-operated valves is overcome in this type of compressor by operating the valves only when the pressure on each side of the valves is nearly the same and then they are quickly moved to the proper position by cams, which give a rapid movement at the critical moment. In addition to this arrangement there is an elastic connection that prevents cutting of the valve or seat even if the lubrication be deficient. By having the inlet valves mechanically operated there is no drag on the machine owing to the partial vacuum necessary to lift the spring-actuated valves. Although the vacuum necessary to lift a properly constructed poppet valve is very slight, the Norwalk company claim that the loss is between three and four per cent. at sea level and that it becomes much more proportionately at higher altitudes. The shop compressor illustrated is so constructed that it may be clamped to a 6" vertical pipe and thus use a very limited amount of space, a feature that is often of considerable importance when a compressor is to be installed in an already over-crowded engine room.

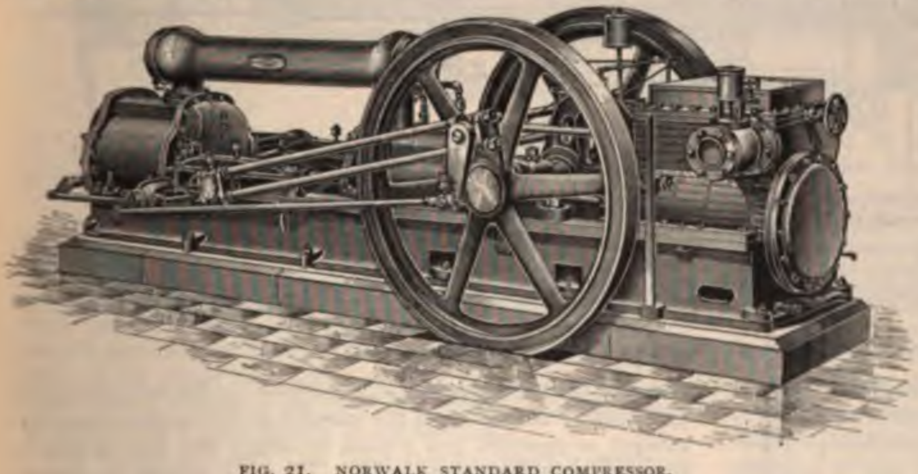

FIG. 21. NORWALK STANDARD COMPRESSOR.

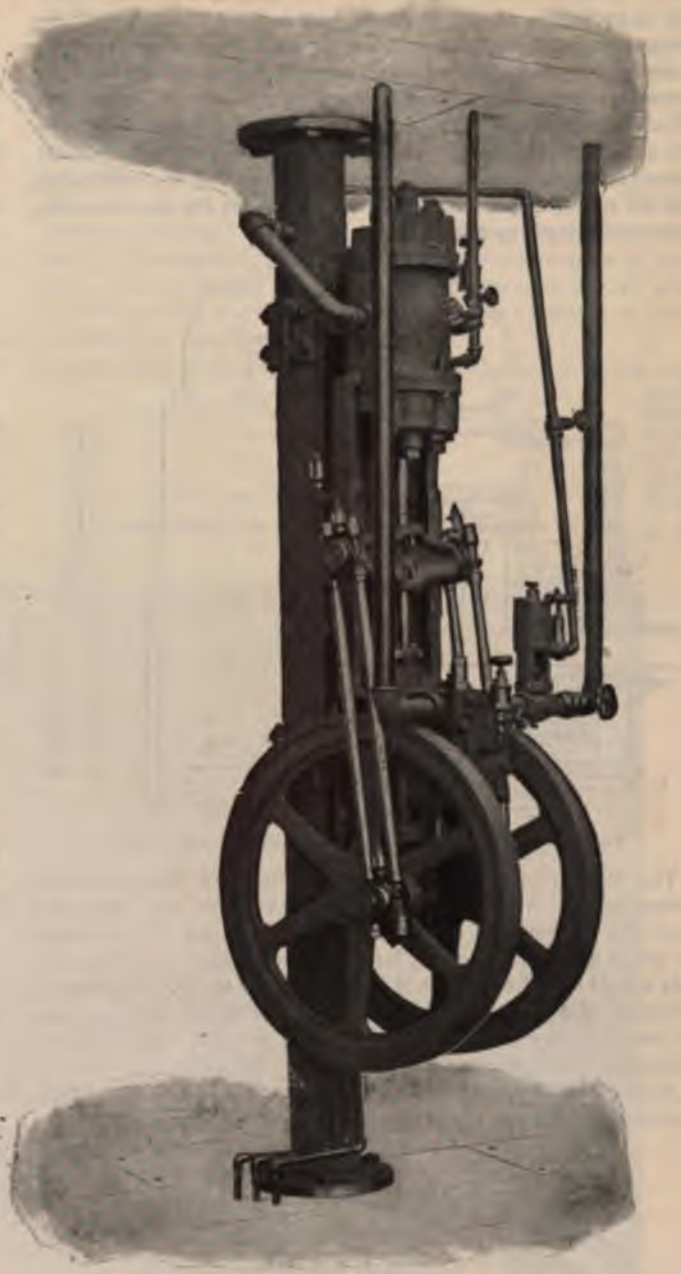

FIG. 22. NORWALK VERTICAL SHOP COMPRESSOR.

One of the most ordinary losses that is too prominent in the ordinary shop compressed-air system is that which results from leaky pipes. As any one knows who has had any practical experience, the amount of air that will pass through a very small opening when under pressure is enormous and one of the most necessary features of a shop system is to have all the pipes and connections absolutely tight. While this condition may be somewhat difficult to obtain, it is clearly not impossible when a pipe line 120 miles long has been laid and found to be "bottled tight" under a pressure of 600 pounds per square inch, the pressure being maintained twenty-four hours without appreciable loss. This remarkable pipe line was equipped with Norwolk compressors and it is safe to say that the efficiency of the compressors was greatly increased with such favorable conditions. If the pipes had been laid as carelessly as they are often erected in shop systems, no compressor, no matter how well built or how efficient in itself, could have given satisfactory results.

A compressor built by the Rand Drill Company is illustrated in Fig. 9 on page 113 and is of the duplex steam engine and compound air-cylinder type, with an intercooler between the two air cylinders, as indicated by the vertical connection between the two. The intercooler is so constructed that the air after having been compressed to the first stage is compelled to circulate in thin streams over a mass of brass or copper pipes through which a constant circulation of water is maintained. The heat of compression is thereby reduced before the second compression and a much more effective cooling effect is realized when the correct proportions between the two cylinders exist, than can be ef-

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fected by simple water jacketing. The latter is a good mechanical expedient well calculated to increase the durability of the compression cylinder, but its cooling effect on the delivered air is necessarily quite limited. In compound compressors with intercoolers there is no danger from the disastrous explosions which have often wrecked compressors of the simple type. In the simple form, the air sometimes becomes so heated under favorable circumstances and heavy pressures that the lubricating oils fed into the cylinder "flash" and demolish the machine with attendant disastrous effects.

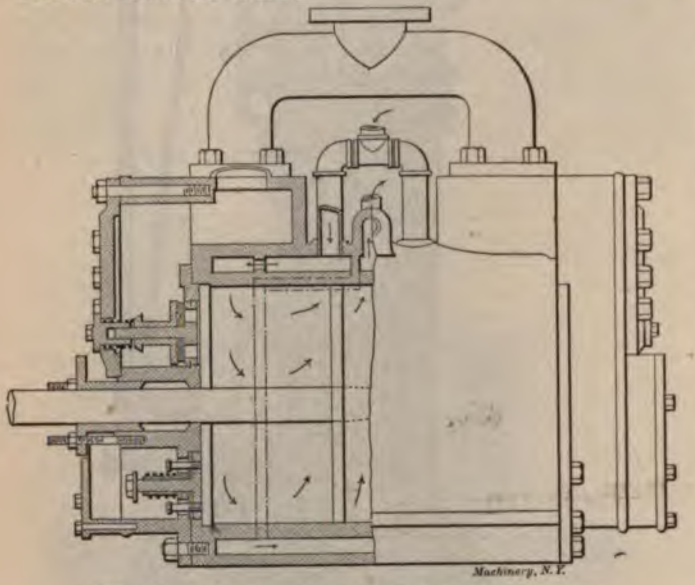


FIG. 23 HALF SECTION OF CLAYTON AIR CYLINDER.

The Rand company make quite a feature of compressed-air reheaters, which are to be used at the ends of long lines and raise the temperature of the air to a degree that is practicable to use in a motor. A great increase of efficiency is obtained by this simple expedient which is said to involve the burning of only about ⅙ of a pound of coal per H. P. per hour. The increase of the efficiency is put at from 25% to 35%, so that if the efficiency of the compressor in delivering the air to the reheater is from 60% to 70%, the use of a reheater will make the total efficiency of the plant 100% or over with an expenditure of a very insignificant amount of coal considering the results. Of course reheating is practicable only where the consumption of air is large as the cost of the attendance would be prohibitive. However, if natural gas or some other source of heat is available that requires no attendance, the reheater enables a considerable gain in economy to be obtained and also renders the motors less liable to freeze up.

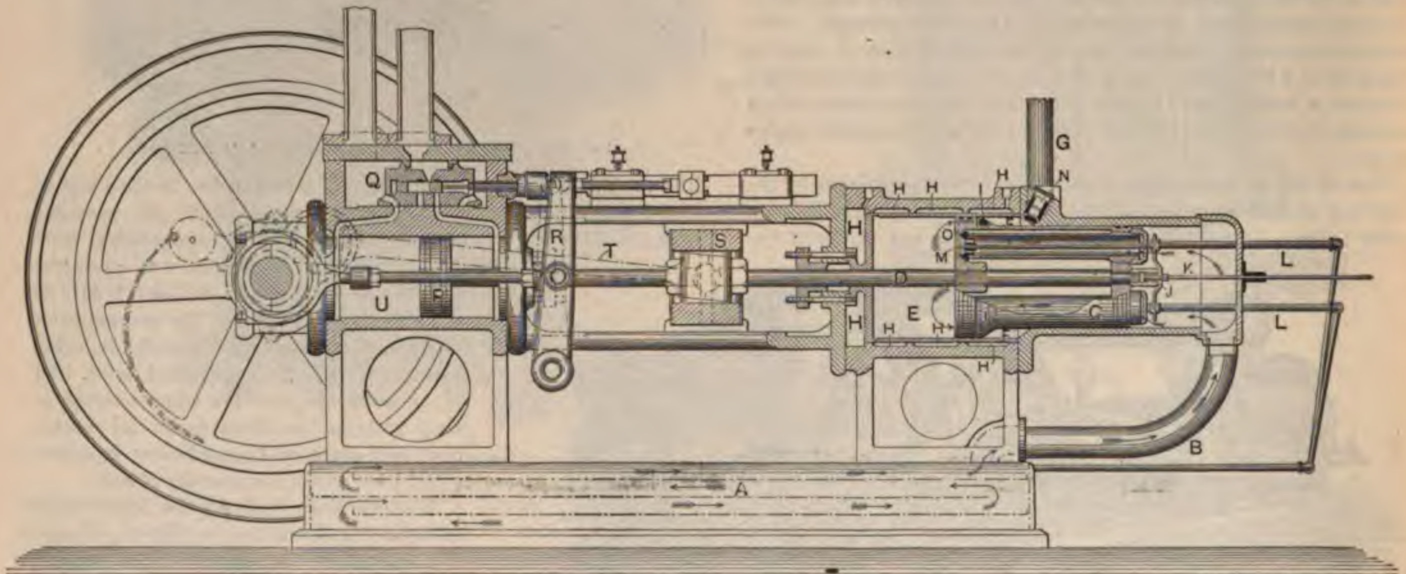


FIG. 24. SECTION OF SHEPARD COMPRESSOR.

The compressors manufactured by the Stillwell-Bierce & Smith-Vaile Company are represented in the two-page cut by Figs. 1 and 3. Fig. 3 shows the type that is calculated for shops that require a compressor of moderate capacity. The cylinders of all machines are water jacketed, the jacket extending into the head as well as around the cylinder. The larger compressors are provided with mechanically-operated inlet valves. In addition to horizontal machines, vertical compressors in single and compound are also manufactured.

### Belt-driven Shop Compressors.

The compressor shown in Fig. 8 in the group cut is manufactured by the Clayton Air Compressor Works of New York and is a belt-driven machine suitable for shop use. It is built with the air-inlet valves exposed to the atmosphere so that the air supply can be taken from the room in which the machine stands or the air valves will be enclosed and provided with pipe connections so the supply may be taken from the outside of the building, which is always preferable for reasons previously stated. The air cylinder is provided with an improved water jacket, which is shown in partial section in Fig. 23. The arrows indicate the water circulation, the water is compelled to circulate by reason of the partitions from the center to and around the ends of the cylinder where the heat resulting from compression is the greatest. The water then passes around the center of the cylinder and out at the top, thus tending to preserve an equable temperature throughout the whole, since the water when coldest passes over the hottest portions of the cylinders and then traverses around the central part which is not at the highest temperature resulting from compression.

A neat and effective form of shop compressor (Fig. 7) is that manufactured by Pedrick & Ayer of Philadelphia. This machine is of the compound type, having water jacketed cylinders and trunk pistons. The feature of trunk pistons is an important point in a shop compressor that is to be efficient and run with a minimum of attention. The cooling effect of the water jacket is doubled by reason of every other stroke being a compression stroke instead of each stroke as is the case in the double acting form. In this machine the water circulates around the valve chambers and from there around the cylinders and out at the top, where the heating effect is a minimum. The cylinders are made of double the length of the stroke so that the trunk pistons do not extend over the top of the cylinder at the end of the stroke, thereby preventing the lodgment of dust on the pistons. An automatic belt shifter is provided that will work within a limit of 3 to 5 pounds, and variation of pressure is easily effected by simply adjusting the ball on the lever arm. This company in their catalogue call attention to the fact that it is best to carry the pipe from the machine to the receiver as nearly straight as possible, and it may be added that this advice is equally applicable to all positions. The use of elbows for changing the direction of a pipe should be abolished wherever possible and all changes in direction effected by long bends in the pipe itself. While this practice may entail some additional expense at the outset, it will be found an investment that will pay well. An elbow in an air supply pipe of the shortest possible bend or having a radius equal to one-half the diameter of the pipe will retard the flow as much as 120 diameters of the pipe so an elbow of the above dimensions in an 1½" pipe would be equal in retarding effect to about fifteen feet of pipe. It is evident that a few elbows of this description in a shop equipment will have a serious effect on the efficiency of it, if the pipes be of limited capacity. If necessary to use elbows, use those of as large radius as can be obtained, as the retarding effect is greatly lessened thereby, an elbow of a radius twice the diameter of the pipe retarding the flow only as much as a straight section nine times the diameter of the pipe in length.

We illustrate in Figs. 12 and 15 two forms of shop compressors built by the Curtis & Co. Mfg. Co. of St. Louis, Mo., the one being a simple machine and the other being the compound type. These machines also have trunk pistons and are water jacketed on the sides of the cylinders and throughout the upper cylinder head. The governing mechanism is automatic in action and will regulate the desired pressure within any reasonable limit. The machine has tight and loose pulleys, but the governing is not done by shifting the belts, but is accomplished without stopping the compressor. It also has the feature of being arranged so that by turning a valve the machine may be started without load and compression started after the machine is in motion.

The compound belt-driven compressor shown in Fig. 15 has an intercooler between the high and low-pressure cylinders in addition to the water jackets around the cylinders and in the cylinder heads. This machine is also provided with the automatic governor mentioned in connection with the simple compressor and also has the trunk pistons which render the cooling effect of the jacket more effective. The intake cylinder is provided with a connection on the inlet so that the air supply may be taken from a point outside of the building.

The Curtis Company also build steam-actuated compressors on substantially the same lines as the belt-driven design and also build one with a direct connected gas or gasoline engine.

### A Novel Air Compressor.

The Havana Bridge Works of Montour Falls, N. Y., are building a compressor that is of more than ordinary interest and which is illustrated in Fig. 25 and shown in section by Fig. 24. The effort in the Shepard compressor is to obtain isothermal compression as nearly as possible and the method used is very simple. As we have previously stated better results are obtained in the stage system with intercoolers between the compression cylinders than can be realized in any single cylinder machine depending on water jackets for the cooling effect. But in the compound compressor, the first compression cylinder is working under exactly the latter condition although the compressive effect is only a fraction of the total work. The loss in the first cylinder, however, is proportionately greater for the first stage than for the succeeding stages, having equal increments of pressure. The percentage of work lost in compressing dry air when no cooling takes place, the compression being adiabatic, is shown in the following table:

Compression to gauge pressure of 15 pounds, loss of power 9.2%
" " 30 " 15.0%
" " 45 " 19.6%
" " 60 " 21.3%
" " 75 " 24.0%
" " 90 " 26.0%
" " 105 " 27.4%

This loss occurs on account of the subsequent cooling of the compressed air which always takes place in ordinary practice and of course the nearer the compression approaches isothermal conditions, the less the loss. In the Shepard compressor, the air is drawn into the base of the machine where it passes over pans of cooling water A and through a falling spray which effectually cools and removes dust from the incoming air. It then passes through the passages in the trunk piston C and enters the first compression chamber. The return stroke of the piston compresses the air and it immediately begins to fill the annular space F surrounding the piston, a condition that does not occur in the ordinary systems. In the passage of the air to the second compression chamber it is cooled by passing in a thin stream through the annular valve I and against the inner walls of the water-jacketed cylinder. It will be seen that the compression approaches the isothermal condition as all parts of the cylinder charge are brought in close contact with the cooling surfaces while compression takes place. We are informed that the efficiency of this system of cooling is about 83%, or practically as efficient as the discarded water injection compressors with none of their practical disadvantages.

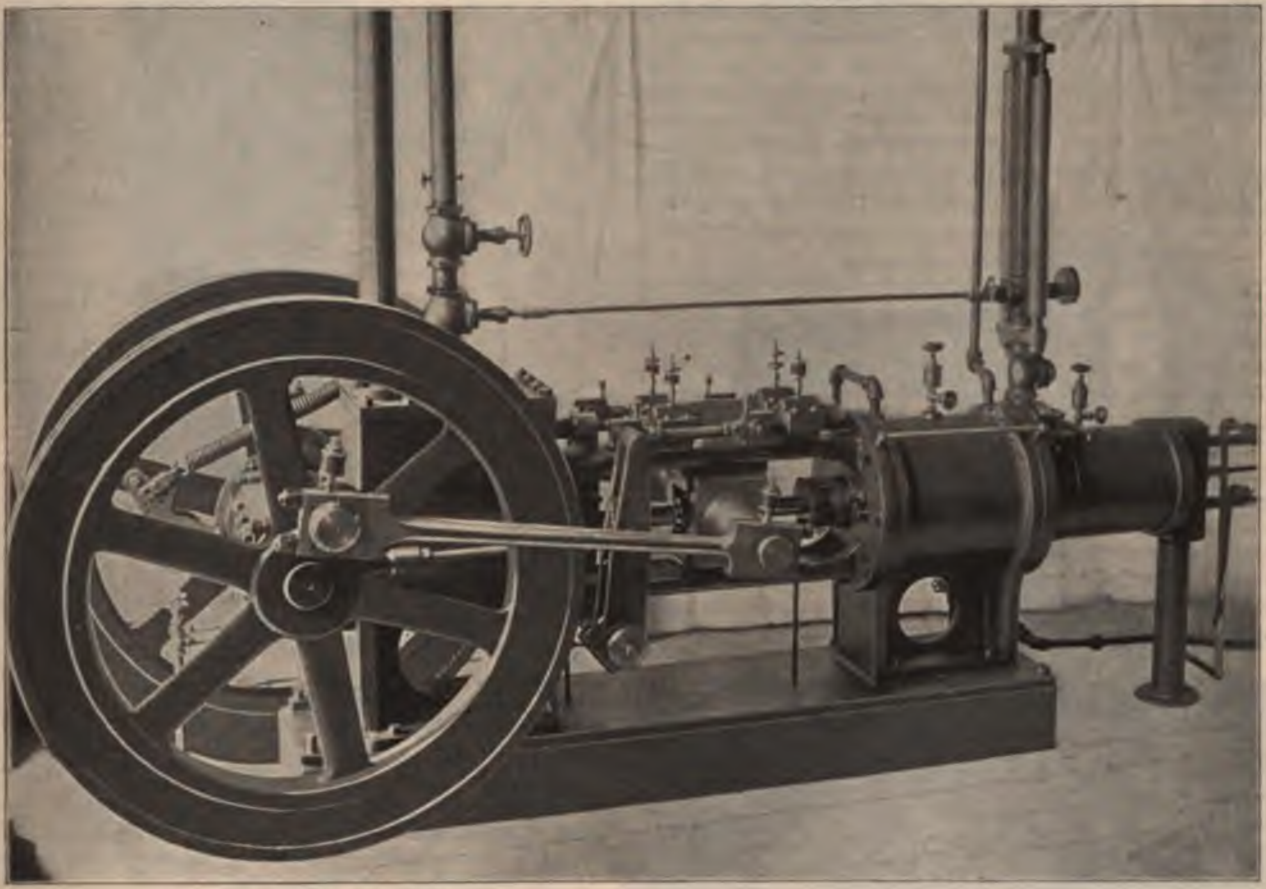


FIG. 25. SHEPARD AIR COMPRESSOR.

The construction of this compressor is simple and is well calculated to find favor on this account as well as its features of economy. The steam engine is of the automatic cut-off type and a novel governing device is used so that a constant pressure will at all times be maintained in the pipe system. An air governor is provided which acts on an auxiliary throttle valve in the steam pipe that is between the main valve and the steam chest. There is a by-pass around the auxiliary valve which allows enough steam to pass to run the compressor slowly when there is no load. When the receiver pressure has reached the maximum point, the air governor shuts the auxiliary valve and then the only steam supply that can reach the engine must enter by the by-pass. The result is that the speed of the engine immediately slackens and the inlet valves to compressor do not open so that the machine continues to run slowly with no load until the pressure is reduced when the auxiliary valve opens and the speed increases. The inlet valves then operate and the work of compression is again resumed.

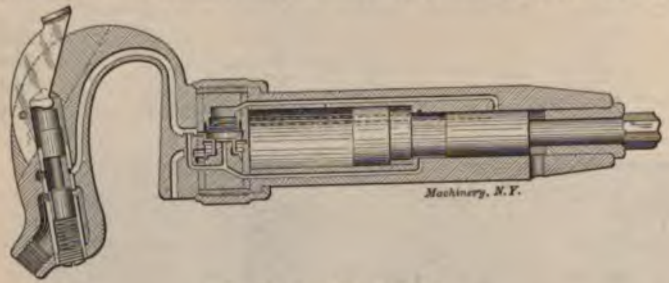


FIG. 26. BOYER HAMMER.

### Compressed Air Hoists.

The hoist shown in Fig. 11 is made by Pedrick & Ayer and is known as their No. 6 style. It is made for lifts from 450 pounds to 14,000 pounds with an air pressure of 80 pounds per square inch at the operating valve. These hoists have automatic operating valves and are air governed. They are manufactured in a variety of lengths to suit the conditions of head room and the lift desired.

A special form of hoist manufactured by the Curtis & Co. Mfg. Co. is illustrated in Fig. 16 which is intended for places where the head room is very limited, and one of their standard straight lift hoists in Fig. 13. These hoists have among other features automatic stops, speed regulators and ball and socket hooks. A speed-adjusting device is of special value in pneumatic hoists as a careless or incompetent operator may cause serious accidents by raising or lowering too rapidly. The writer has seen hoists made that had no speed regulator except that the throttle valve was very small so that with a full opening the piston could raise a load only at a safe speed. The exhaust valve being of the same dimensions, the lowering was controlled in the same manner. This arrangement can scarcely be commended, especially if the top of the cylinder has a large opening to the atmosphere. Although such a hoist can raise and lower at a limited rate only, there is danger of wrecking it if a chain breaks while carrying a load. The confined air will shoot the piston with great force out of the top and perhaps make a bad accident still worse. The top head in a simple home-made hoist should be provided with an outlet of limited size and then there is no danger from an accident of this kind.

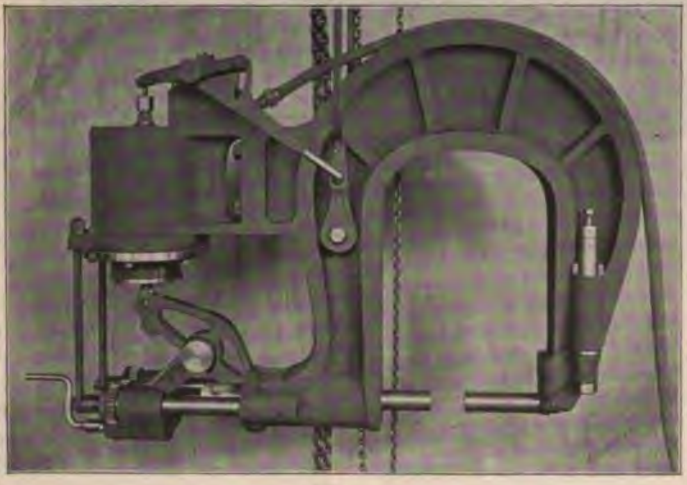


FIG. 27. SHEPARD RIVETER.

### Tools and Appliances.

The pneumatic hammer, used for chipping, calking, beading, riveting and other work, is a very interesting tool, and is being manufactured in a variety of forms by a number of companies. The one illustrated in section by Fig. 26 is the well-known Boyer tool, which is made by the Chicago Pneumatic Tool Company and is adapted in weight and construction to any service required. The new Boyer hammer for driving rivets from ⅝" to ¾" in diameter weighs 13 pounds and has a piston stroke of 5". The piston reciprocates at a rate of about 1,800 strokes per minute and with an air pressure of 90 to 100 pounds per square inch, the tool uses 20 cubic feet of free air per minute. Where heavy riveting is to be done and the character of the work permits, a yoke riveter made on the same principle can be used which is of much lighter construction than the ordinary form that depends on pressure alone to form the rivet head. In Figs. 4, 5 and 17 are shown scenes taken from actual construction work in which these tools are being used.

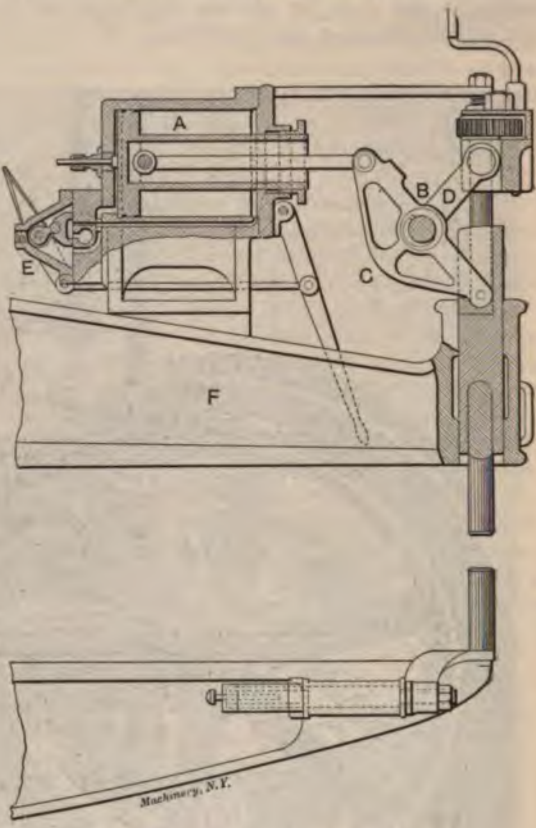


FIG. 28. SECTION OF SHEPARD RIVETER.

The Havana Company also build the pneumatic riveter shown in Fig. 27 which contains an interesting toggle-joint arrangement. In the ordinary form of riveter, using the toggle-joint principle, trouble is often met when the thickness of the parts being riveted is less than that for which the machine is adjusted, a condition that is likely to often occur on structural work. With the ordinary form, the pressure on the parts increases with the approach of the toggle arms to a straight line and would theoretically reach an infinite quantity when the arms finally coincided with the straight line joining their centers. The result is that such machines are often broken or damaged by the enormous stresses developed, but in the Shepard riveter this trouble is obviated by an eccentric pin indicated at B, Fig. 28, which allows the pressure to reach a predetermined amount and then the pin automatically shifts and allows the plunger to advance at a practically uniform rate and thus exert no greater pressure than what the yoke is proportioned to resist.

A pneumatic tool make by the Q. & C. Company is shown in section by Fig. 29 and is known as their valveless hammer, the piston acting as the valve. The construction of this tool is very simple and one easily understood. The compressed air is admitted to the cylinder through a passage of generous dimensions which is not easily clogged and which can be opened and inspected throughout with very little trouble. The compressed air being in communication with the annular space around the piston, it tends to drive the piston backwards by reason of the pressure on the rear shoulder, but the air finding admittance to the cavity behind the piston through the ports in the piston as shown in the cut, forces it ahead and delivers the blow but at that moment the ports are opened to the atmosphere. The pressure behind the piston being removed by the exhaust, the pressure under the shoulder which is being constantly maintained, returns the hammer and the cavity behind the piston fills on the back stroke until the pressure overcomes the force of the backward stroke and again drives it forward. A hammer for heavy work that is capable of driving ⅞" rivets and can be held by one man, utilizes the counter-balance principle and greatly reduces the shock and jar incident to the rapid reversal of a heavy piston. In this tool two parts strike alternate blows, one being a piston and the other a movable cylinder surrounding it. A pneumatic tool for lighter work also uses the counter-balance system, but in this tool there are two pistons working in opposite directions and only one delivers a blow on the tool.

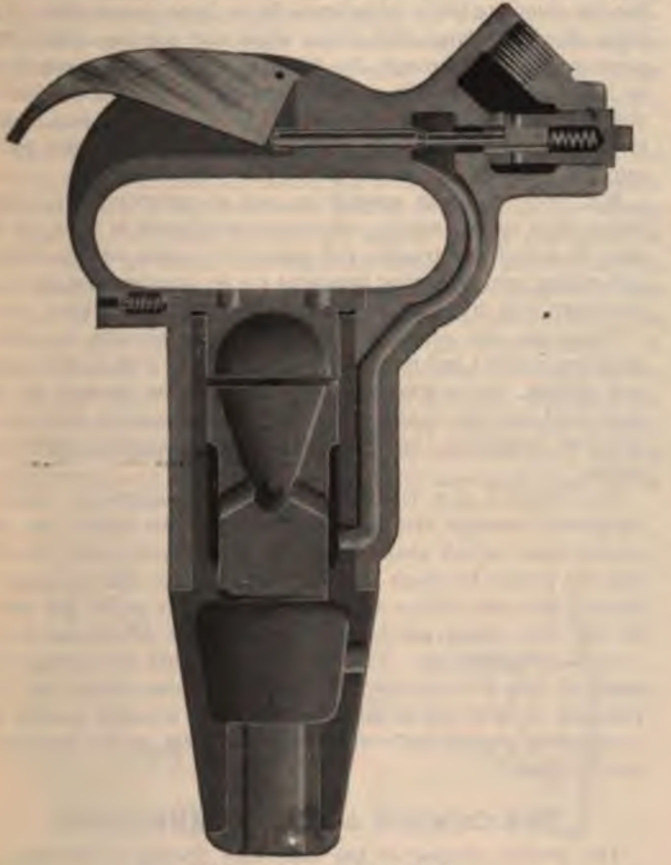


FIG. 29. Q. & C. HAMMER.

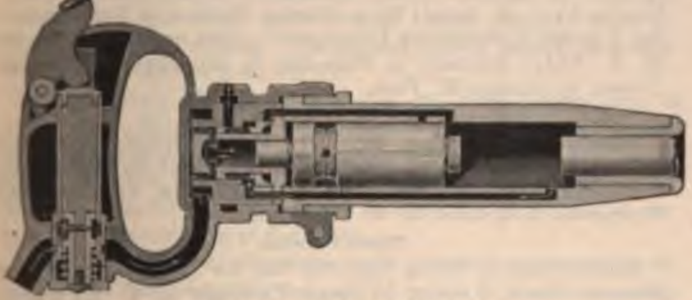


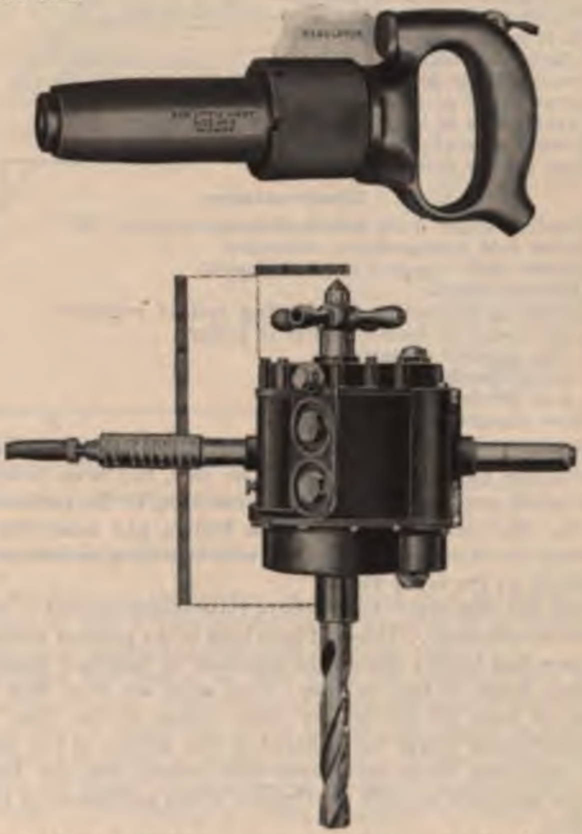
FIG. 30. TILDEN HAMMER.

The function of the other piston is to absorb the shock of reversal and to render the tool more generally agreeable to the operator. This company also manufacture yoke riveters with reciprocating hammers for driving rivets, which have a capacity up to 1¼" rivets. The yoke being of light construction, the riveter is well adapted for work that makes the heavier compression tools unsuitable.

The Standard Railway Equipment Company, of Chicago, are manufacturing pneumatic hammers and air motors suitable for driving drills and other shop tools that may be used in erecting work. Fig. 6 shows the use of their pneumatic hammer in chipping the edge of a locomotive flue sheet. Their piston air drills for machine and wood-working shops are shown also in Figs. 14 and 10. The piston drill for machine shops is well adapted to driving drills and tapping holes in fire-boxes for stay-bolts. Stay-bolts may be screwed in with this machine after the holes are tapped and much time and labor saved. The machine is positively driven so that when the work stops the tool, the air does not continue to blow through as is the case with impulse motors, but has practically the same action as in a piston engine.

The Tilden pneumatic hammer is illustrated in section by Fig. 30 which shows the general construction and also the oil chamber in the handle, which measures out and delivers a constant supply of lubrication to the incoming air. The reciprocating piston and valve are thereby constantly lubricated, a condition that of course increases the effectiveness and durability of the working parts. This tool is to be manufactured by the International Pneumatic Tool Company, of Chicago.

The pneumatic hammer shown in Fig. 31, is made by the Standard Pneumatic Tool Company of Chicago, as is also the piston aid drill shown in Fig. 32. The latter tool is particularly of interest as it is a very powerful and compact tool with the feature of high speed and reversibility by simply turning the grip handle either right or left. The grip handle also admits or shuts off the air supply, the direction of the motor depending on which way the handle is turned by the operator. The same general features are incorporated in a breast drill which weighs eight pounds and will drill holes from 1-16" to ½". The same tool is also made with a feed screw and is said to be the smallest piston air drill manufactured. This style of drill consumes 15 cubic feet of free air per minute at a pressure of 80 pounds per square inch.



FIGS. 31 AND 32. STANDARD PNEUMATIC TOOL COMPANY'S HAMMER AND DRILL.

The pneumatic hammer manufactured by this company has a regulator which admits the air to the cylinder under whatever pressure (within certain limits) is required by the work in hand. The piston is cushioned on the return by the exhaust, thereby increasing the economy and at the same time making the tool easier to hold on account of the reduced vibration. A pneumatic motor chain hoist is also made, which is an application of their piston motor to the worm of a chain hoist, thus doing away with manual labor in the operation of these indispensable shop appliances. It is obvious that this style of hoist possesses some advantages over the piston and cylinder type as it will operate in very limited head room and can also be easily transported to any part of the shop where the air supply is available.

## MEETING OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The seventh annual meeting of the Society of Naval Architects and Marine Engineers was held in this city on Thursday, November 17. There were about 100 in attendance and several of the papers were of unusual interest since they were in a measure based upon actual experience with our naval vessels in action.

The two papers that were of the greatest general interest, both because of the standing of their authors and on account of the importance of the subjects treated, were the one by Admiral Melville upon "Causes for the Adoption of Water-tube Boilers in the United States Navy," and the one by George W. Dickie, Manager of the Union Iron Works, San Francisco, Cal., upon "The Increasing Complications in Warships and how Simpler Arrangements might be Adopted."

As is well known by those who have kept pace with the development of the navy, the day of water-tube boilers for naval work has come, and Chief Engineer Melville, though at one time opposed to them, or at least not satisfied that experience warranted their adoption, has become thoroughly convinced that the type is now sufficiently established and gives so superior results that it is to be preferred to the older Scotch boiler which has held sway for so many years.

The advantages and disadvantages of water-tube boilers are stated by the Admiral to be as follows:

### Advantages.

Less weight of water.
Quicker steamers.
Quicker response to change in amount of steam required.
Greater freedom of expansion.
Higher cruising speed.
More perfect circulation.
Adaptability to high pressures.
Smaller steam pipes and fittings.
Greater ease of repair.
Greater ease of installation.
Greater elasticity of design.
Less danger from explosion.

### Disadvantages.

Greater danger from failure of tubes.
Better feed arrangements necessary.
Greater skill required in management.
Units too small.
Greater grate surface and heating surface required.
Less reserve in form of water in boiler.
Large number of parts.
Tubes difficult of access.
Large number of joints.
More danger of priming.

He traced the experiences of the navy with water-tube boilers during the past ten years, which, he said, had been favorable, and called attention, among other instances, to the performance of the Marietta, which had these boilers and made the trip around the Horn in conjunction with the Oregon just as successfully as the latter vessel.

The fact that water-tube boilers raise steam quickly is of the greatest advantage. It would have been of the greatest advantage to have had boilers during the blockade of Santiago capable of raising steam in half an hour. Coal need not then have been used to keep all the boilers under steam all the time. The Massachusetts might have shared in the glories of the fight if she had been fitted with water-tube boilers and the Indiana might have kept up with the Oregon which had steam on all her boilers.

The higher steam pressures with water-tube boilers give us smaller and safer steam pipes and better valves. It increases the efficiency of the engines, and, in fact, the use of quadruple expansion engines necessitates the use of water-tube boilers.

Furthermore, for naval vessels with protective decks, the facility with which water-tube boilers can be removed or completely renewed may of itself justify their adoption at times.

Admiral Melville said that he had always opposed the use of boilers containing screw joints in contact with the fire, and had attempted to secure boilers having no cast metal in the pressure parts. Cast steel is not yet good enough to put between 300 pounds of steam and our firemen. He believes in straight tube boilers as being easier of examination and repair than bent tube boilers and in boilers having as few joints as possible. Water-tube boilers must have freedom of expansion of the various parts, and the simpler the boiler the better. It should not be necessary to introduce reducing valves between the boilers and the engines to secure a steady steam pressure at the latter, nor should it be necessary to have automatic feed arrangements to insure steady water level in the boilers. To be successful a boiler must be easy of repair. Lightness is a natural attribute of all water-tube boilers, but it is not wise to go too far in this direction. The ratio of grate surface to fire surface occupied for the complete boiler plant must be as large as possible. The units should be large, the grates short and not too wide. The passage of gases through the tubes should be sufficiently long to insure economy. These gases should be well mixed before entering the spaces between the tubes for the same reason and to prevent smoke. The circulation of the water in the boiler must be free.

Mr. Dickie's paper appeals to one as embodying common sense ideas upon a subject where common sense is need. What may be called the arteries and nerves of a ship are the piping and wiring, which in most instances are so intricate that an engineer may well dread attempting to keep them in working order.

There are also on the modern battleship seventy or eighty auxiliary engines and motors. All of these, as well as the piping and wiring, are a gradual evolution like the growth of the ship itself and the result is that their arrangement is not one of previous planning, but one designed to supply immediate needs.

Mr. Dickie's plan is to have a central passageway running lengthwise through the center of the ship, just below the protective deck, which shall contain all pipes, wires, etc. In this way the pumps for fresh and salt water and for drainage can be located near the boilers and the pressure kept on all the mains all the time, from which direct connections are made to the various compartments. This passageway would also contain the armored tube which protects the wires, speaking tubes, etc. His plan was worked out in detail and seems to simplify greatly the complicated piping and scattered arrangement of the auxiliaries now in vogue.

* * *

## THE COMING A. S. M. E. MEETINGS.

The annual meeting of the American Society of Mechanical Engineers is to be held at the society house on December 5 to 8, inclusive. The list of papers is an attractive one, especially to those who are interested in steam engineering. On Tuesday evening, December 5, Admiral Melville will deliver the president's annual address and the professional papers will be presented during sessions on Wednesday morning, 10 o'clock; on Wednesday evening, at 9 o'clock; on Thursday morning, and the closing session will be Friday morning, December 8, at 10.30 o'clock. The subjects of the papers are as follows:

### First Session.

Report of the Committee on the Code for Boiler Testing; The Steam Engine at the End of the XIX Century, by R. H. Thurston; Berthier Method of Coal Calorimetry, by C. V. Kerr; Test of Two Pumping Engines at St. Louis Water Works, by J. A. Laird; New Graphic Method of Constructing the Entropy-Temperature Diagram of a Gas or Oil Engine, by H. T. Eddy; Pressure in Pipe due to Stoppage of Flowing Liquid, by George M. Peek.

### Second Session.

Liquefaction of Gases, by A. L. Rice; Curved Glass Blue Print Machine, by P. M. Chamberlain; A Metal Dynagraph, by P. M. Chamberlain; Education of Machinists, Foremen and Mechanical Engineers, by M. P. Higgins.

### Third Session.

Experiments on Using Gasoline Gas for Boiler Heating, by Herman Poole; Friction of Steam Packings, by C. H. Benjamin; Friction Tests of a Locomotive Slide Valve, by F. C. Wagner; Note on Fly-wheel Design, by A. J. Frith; A Broken Flywheel and How it was Repaired, by James McBride; Efficiency Test of a 125 H.P. Gas Engine, by C. H. Robertson; Strength of Steel Balls, by J. F. W. Harris; Colors of Heated Steel at Different Temperatures, by M. White and F. W. Taylor.

### Closing Session.

Impact, by W. J. Keep; The Southern Terminal at Boston, by H. J. Conant; High Hydrostatic Pressures and their Application to Compressing Liquids; A New Form of Pressure Gauge, by F. H. Stillman; The Value of a Horse-Power, by G. I. Rockwood.

# PYROMETERS.

### A BRIEF DESCRIPTION OF VARIOUS METHODS THAT HAVE BEEN USED FOR MEASURING HIGH TEMPERATURES.

Wm. Wallace Christie.

Webster defines "Pyrometer" as "an instrument for measuring degrees of heat, above those indicated by the mercurial thermometer, constructed usually on the principle of registering or measuring, by means of multiplying levers and a scale, the change in length of some expansible substance, on a metallic rod, when exposed to the heat to be measured."

The name was first applied by Muschenbroek, in 1731, to an instrument he devised for measuring changes produced in metals by heat, and it is still sometimes used to designate an instrument of this class invented by him for measuring the expansion of solid bodies by heat. De Saguliers improved Muschenbroek's instrument. Between 1736 and 1780 Ellicott, Wedgewood and Guyten also invented instruments of the same character, but none of them give accurate results for very high temperatures. In 1881, Professor Daniell invented his pyrometer, for which he received the Rumford medal of the Royal Society. Daniell's instrument consisted of two distinct parts—a register and a scale. The register was detached after reading the scale in a known temperature, and exposed to the heat to be measured, after which it was replaced in the scale and a reading taken of the temperature to be measured. Professor Daniell adopted the doubtful assumption that equal increments of length are the effects of equal increments of heat. The register, before heating, is placed on the scale (e) being set on (l).

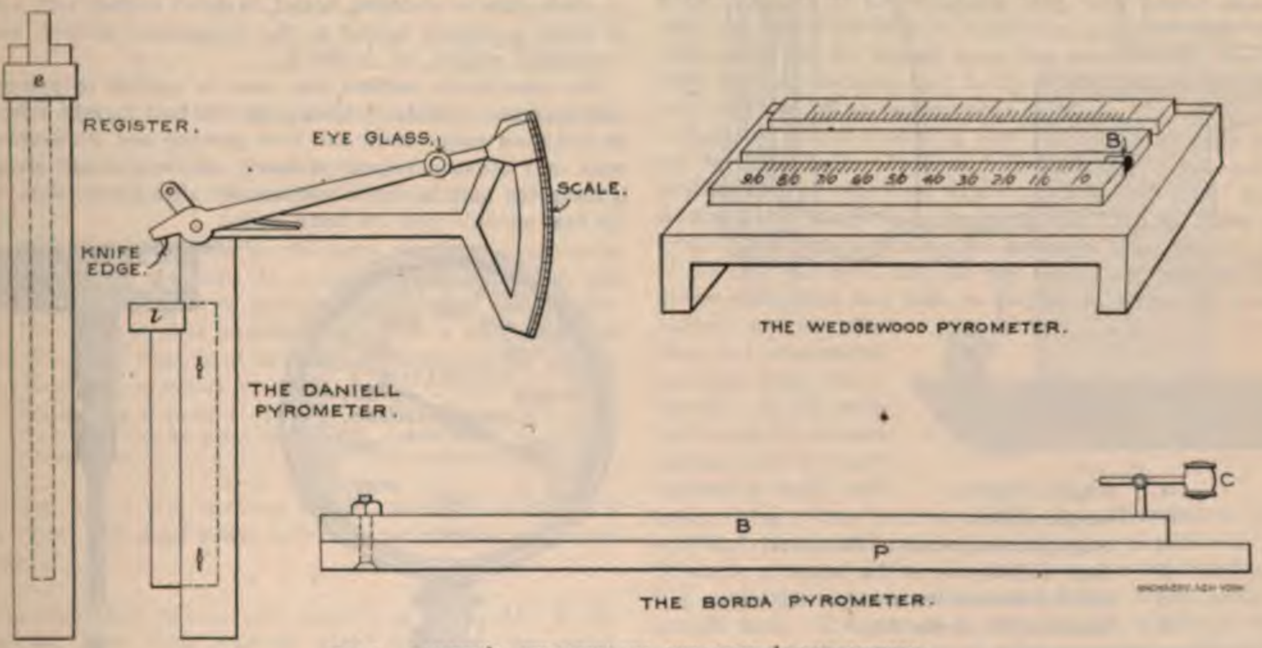


FIG. 1. DANIELL'S, WEDGEWOODS AND BORDA'S PYROMETERS.

Wedgewood's pyrometer consists of three copper bars 6 inches long, fixed upon a metal plate with a distance of ½ inch between the first and second at one end and 1-12 inch less at the other end. The second and third bars are the same distance apart as the narrowest part of the slot between the other two at one end and 1-12 inch less at the other.

A one-half inch bar of potter's earth is placed in the heat to be measured, then removed and cooled, when it is moved along the wedge-shaped slot as at (B) until it just fits, and the temperature is read from the scale. The instrument, however, is not very accurate.

Brogniart's pyrometer is similar to Wedgewood's, and consists of a steel, silver, or platinum bar, placed in an oven, one end being fixed and the other acting on a porcelain rod, which projects from the furnace. This rod presses against the short arm of a bent lever passing in front of a graduated scale. Borda's pyrometric standard was devised originally as the measure of the great arc of the meridian in France.

It consists of a brass bar (B) pivoted at one end to a bar of platinum (P) of nearly equal length, a scale being marked on (P). The microscope (C) enables change in temperature to be easily noted, and with considerable accuracy.

In 1851 Mr. Ericsson produced a pyrometer in which temperatures were ascertained by the tension of a permanent volume of air or nitrogen measured by a column of mercury under a vacuum.

M. F. Becquerel, of Geneva, in 1864, suggested a thermo-electrical apparatus, which has been proved very reliable.

C. W. Siemen's electrical resistance pyrometer will measure the hottest furnace heat.

Deville, Troost and Regnault proposed instruments similar to the air thermometer. Ducomet suggested the employment of a series of alloys having a known melting point, which method has been developed by Carnelley.

The Ducomet pyrometer is constructed on a principle which makes it applicable only to approximate determinations. A series of rings made of alloys, with a different melting point, are placed over a rod and compressed by a spiral spring. Then the melting temperature of a certain ring is reached, it is squeezed out and the rod jumps up one interval, thus indicating successive higher temperature as they are reached.

The following table will be of value to those desiring to ascertain temperatures at any particular time.

| | | | |
|---|---|---|---|
| Melting point of Tin...... | 228 deg. C. | Lead...... | 325 deg. C. |
| Bismuth .. | 264 deg. C. | Zinc...... | 415 deg. C. |
| Cadmium . | 315 deg. C. | Aluminum | 700 deg. C. |

Gauntlett makes use of the difference of expansion of two rods which causes the rotation of a pointer on a graduated dial.

Trampler uses a hard porous rod of graphite in an iron tube, which when heated expands more than the rod.

Carnelley and Burton, in 1879, claim the invention of a water current pyrometer. The difference of temperature between inflow and outflow in copper tube coiled over the fire, which on comparison with tabulation of results obtained at known temperatures, enables the proper temperatures to be closely approximated.

Amagat's and Saintignon's 1883 pyrometers are similar to the above. M. de Saintignon's pyrometer has been used with great success in blast furnaces, glass works, porcelain houses, and other operations requiring very high temperatures.

Saintignon's pyrometer consists of two thermometers (AA), Fig. 2, connected to the main tube with a hose. Water with a head of 10 feet from reservoir (R) passes through filter (F) and then floods the thermometer bulbs (AA). The parts are so planned that 25 deg. raise in furnace heat produces 1 deg. at the thermometers. A movable scale (S) is provided, which is properly graduated.

Messrs. Boulier Bros. patented in 1883 another form of water current apparatus, the difference being one of detail only.

Siemen's first pyrometer was of the calorimetric type, followed in 1860 by an electrical device based on the principle that the electric resistance of metal conductors increases with the temperature.

Berthelot's U mercury-gauge pyrometer is another method for measuring high temperature, but is unreliable as is shown by Recknagel and Mills.

Shaeffer and Budenberg also have made use of the tension principle, the value of which machine depends on the tightness of the joints of the closed reservoir.

Freu's pyrometer for measuring hot blast temperature makes use of expansion of air, due to heating and moving a colored liquid over a properly graduated scale.

The formula for the Metal Ball pyrometer is:

$$X = \frac{W(T - t)}{w S} + T$$

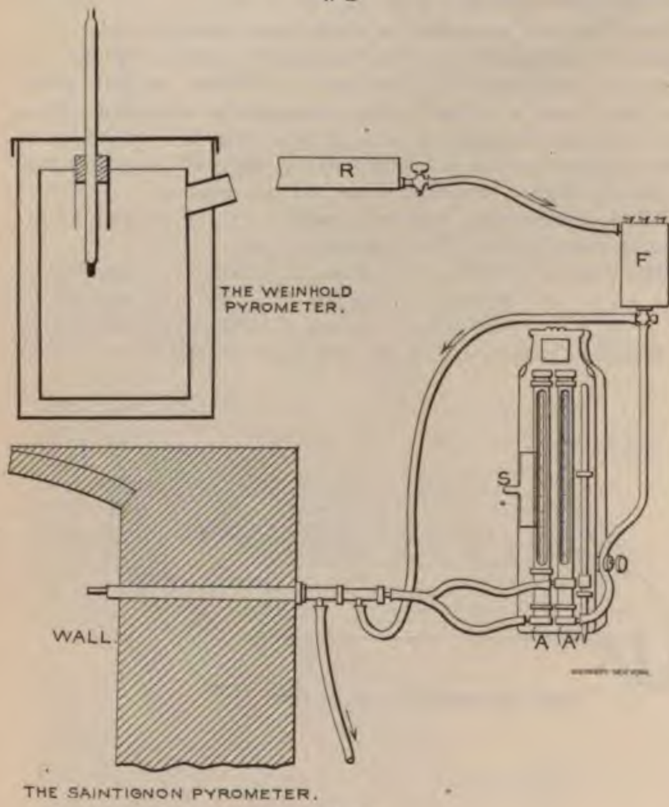


FIG. 2

w weight of water.
W weight of ball.
t original temperature of the water.
T final temperature of the water.
S specific heat of the metal in the ball.
X temperature of the fire.

Le Chatelier's thermo-electric pyrometer is based upon the principle of the measurement of a current of electricity produced by heating a two wire couple, the galvanometer being used to measure the current.

The following table shows the temperatures in degrees Fahrenheit and Centigrade at which the various phenomena take place:

| At Deg. F. | Deg. C. | |
|---|---|---|
| 212 | 100 | Water boils. |
| 618 | 326 | Lead melts. |
| 676 | 358 | Mercury boils. |
| 779 | 415 | Zinc melts. |
| 838 | 448 | Sulphur melts. |
| 1157 | 625 | Aluminum melts. |
| 1229 | 665 | Selenium boils. |
| 1733 | 945 | Silver melts. |
| 1859 | 1015 | Potassium sulphate melts. |
| 1913 | 1045 | Gold melts. |
| 1929 | 1054 | Copper melts. |
| 2732 | 1500 | Palladium melts. |
| 3227 | 1775 | Platinum melts. |
| 2075 | 1135 | White cast iron melts. |
| 2228 | 1220 | Grey cast iron melts. |
| 2651 | 1445 | Semi-mild steel melts. |
| 2570 | 1410 | Hard steel melts. |

In a recent issue of the "Iron Age" Dr. R. Moldenke describes a modification of the Le Chatelier pyrometer. As formerly made, it contained two wires, one of platinum, the other an alloy of platinum with 10 per cent. rhodium, and enclosed in a porcelain tube for insertion to the furnace. The modified instrument has an iron tube around a portion of the length of the wires which is bent to an angle of 90 degrees, and at the end a clay tip is placed about the joint of wires. The tip can be placed in molten metal, and in case of its destruction it can be easily replaced.

The Wiborgh Air-Pyrometer is of the class designed by Regnault, and is adapted to blast-furnaces, tempering furnaces, etc., where determinations from O deg. to 2400 F. deg. are desired.

Seger's pyrometer is a series of slender, triangular fire-clay pyramids which are placed one above the other, and the tumbling over of one after another, as their limits of plasticity are reached, is an indication of the temperature reached—when previously determined for the same materials by some absolute method.

Mesure and Nouel's pyrometric telescope is by far the most convenient, and, giving immediate results, is invaluable when a number of consecutive readings are required, and is in the form of a little telescope which is convenient to have about the person. The principle of its operation depends on the polarization of light.

The Uehling and Steinhart pyrometer is one of the later inventions, and it makes use of the law of the flow of gas through minute apertures.

Tremeschino's pyrometer works on the principle of expansion of a thin plate of platinum, heated by direct contact with a mass of metal previously heated to the temperature desired, and is considered reliable up to 800 C.

The calorimetric method may also be applied to pyrometry with success. A body of known specific heat may be raised to an unknown temperature and then plunged and allowed to remain in a constant volume of water, the temperature of which is measured both before immersion and after it has taken all of the heat possible from the body heated.

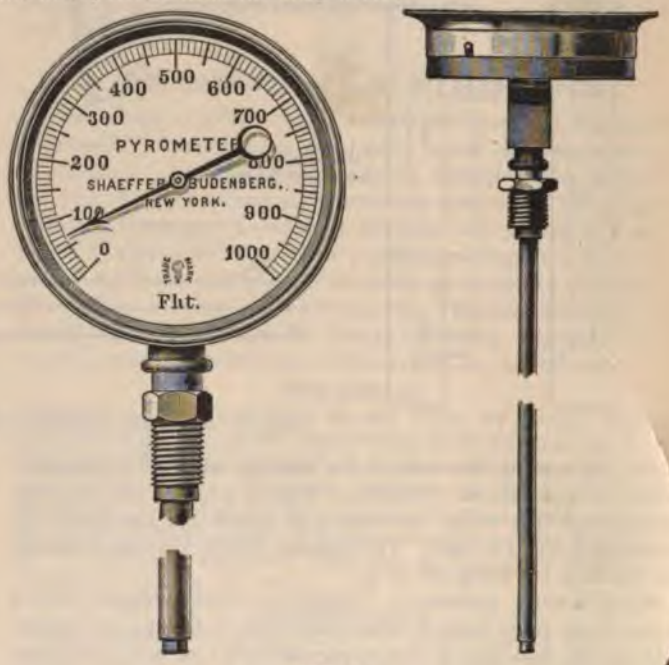


FIG. 3.

The vessel should be well jacketed with polished sheet metal. Bystrom employed a platinum ball to be heated in a clay tube, the ball then being suddenly placed in a water calorimeter. Siemens used a similar arrangement, but with movable scale on the thermometer tube, which, however, proved faulty.

Weinhold's pyrometer consists of an inner vessel made [illegible] of tin plates with two openings, one being for the thermometer and one through which are placed the iron balls. The capacity of the inner vessel is one liter of water. The outer vessel [illegible] of tin also, packed with cotton wool and closed with a lid through which projects the thermometer tube. Three balls of wrought iron, weighing twenty grains each, are used, and by means of special formulae the temperature measured may be calculated.

The writer has experimented with a cast iron ball, placing the same in a boiler furnace and immersing it in a metal case of water, which was previously weighed; but the c [illegible] was not jacketed, and the cast iron was very hard to handle at furnace heat, being very liable to crumble. The determination was a heat higher than that at which cast iron is said to melt, so he cannot recommend as absolutely reliable any such crude outfit as was used. It should be borne in mind that the water in the vessel and the vessel itself should be raised to a temperature nearly as high as one would expect the immersed ball to raise it before the ball is heated.

Ganot's Physics gives these formulae for finding the specific heat of a body:

$$c = \frac{m(\Theta - t)}{M(T - \Theta)}$$

where C = its specific heat,
M = weight of cold water in vessel,
$\Theta$ = temperature to which water is raised,
T = final temperature of the body,
t = original temperature of the water.

After making correction for the vessel of brass, which is polished, m = weight; C = specific heat; t = temperature of water, then

$$M\,c\,(T - \Theta) = m\,(\Theta - t) = m'\,c'\,(\Theta - t)$$

$$c = \frac{(m + m'\,c')\,(\Theta - t)}{M\,(T - \Theta)}$$

$$\Theta = \frac{M\,c\,T + m\,t + m'\,c'\,t}{M\,c + m + m'\,c'}$$

$$T = \frac{(M\,c + m + m'\,c')\,\Theta - t\,(m + m'\,c')}{M\,c}$$

Specific heat of cast-iron (Regnault), 0.12893; melting point, 2732 deg. F.

Specific heat of cast-iron (Pouillet), 0.14000.

Specific heat of brass (Nystrom), 0.094; melting point, 1873 deg. F.

The writer experimented by placing a chunk of cast-iron in boiler furnace on the coal. It crumbled quite badly, but one piece weighing 1.36 pounds was placed in an iron can containing $65.88 - 13.24 = 52.64$ pounds of water at a temperature of 41 deg. F., which was raised to 51 deg. Considering the specific heat of the vessel as 0.1200 we have:

$$T = \frac{\dfrac{[(1.36 \times 13) + 52.64 + (13\ 24 \times .12)]\ 51 - 41}{[52\ 62 + (13.24 \times .12)]}}{1.36 \times .13} = 3118^\circ\ F,$$

which was not a very accurate result apparently, but with a jacket vessel and good sound ball more satisfactory work may be done.

* * *

Some interesting figures were recently given by Mr. P. H. Dudley in "New York Railroad Men" regarding the stored energy of heavy passenger trains. It is estimated that a train of 10 modern passenger coaches is 800 feet long and weighs 650 tons. The stored energy in foot-pounds of the train in motion is 172,172,000 foot-pounds at 60 miles an hour, 25,000,000 less at 55 miles an hour, and 22,000,000 less at 50 miles an hour. The locomotives, so far as ordinary train resistance is concerned, would have no difficulty in maintaining the speed when once attained at 50, 55 or 60 miles per hour. To raise the train from a speed of 50 to 55 miles per hour, however, requires over 25,000,000 foot-pounds of energy stored in the train for the higher speed. With an increase of 500 pounds additional draw-bar tension, this would require a run of 10 miles to store the needed energy. A signal or slow-down may reduce the speed, and all the energy from the higher to the lower speed destroyed by the brakes. The energy must be restored to the train before it can regain its running speed, but whether the lost time can be made depends upon the distance to be run and the ability of the locomotive to store up energy in the train much above the average running speed.

* * *

"Bronze" and "brass" are terms that are often used synonymously, but the former material is a compound of copper and tin while the latter is composed of copper and zinc. Bronze originated among the ancient inhabitants of Egypt, before iron was known, and was almost invariably of the proportion of 10 or 12 parts of tin to 90 or 88 of copper.

## MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—5.

### LATHE TOOLS.

W. H. Van Dervoort.

On the subject of cutting tools for the lathe we will consider only the more general points, as practice alone can bring out the details of proper form and setting.

The common lathe tool as shown in Fig. 40 is a short bar of tool steel of rectangular cross section having a cutting edge formed on one end by forging and grinding. The cutting edges must be hardened and tempered in order that they may properly cut the metals upon which they operate. The form of the cutting edge depends upon the kind and hardness of the metal to be cut, the amount of metal to be removed and whether the cut is to be a roughing or a finishing one. These tools when new are made from six to twelve inches long, their length depending upon the size of the lathe in which they are to be used. As the edges wear and are ground away they are redressed, thus gradually using up the stock and finally leaving a short stub, that is, as a lathe tool, of no further value.

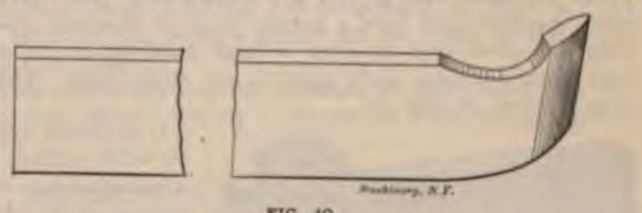


FIG. 40.

Tungsten or self-hardening steel has come into quite general use for lathe tools. It is an "air hardening" steel, and after forging must be kept from water. As it is "hot short" it is exceedingly difficult to forge into any other than the most simple forms. It is several times more expensive than the best grades of ordinary tool steel, and for this reason and also on account of the difficulties met with in forging it, numerous forms of holders for its efficient and economical use have been introduced. In all such tools only the cutting portion is of the self-hardening steel, the holder being a drop forging of mild steel. The cutting portion is of such form that it can be kept in proper condition for work by simply grinding it, thus avoiding the expense of forging. In Fig. 41 is shown an Armstrong tool holder of this class with straight body. It is also made right and left, a left-hand holder being one with the cutting point offset so as to make an angle to the right and a right-hand holder having the cutter pointing to the left. As several cutting points may be used in one holder, a tool of this character frequently takes the place of a number of forged tools.

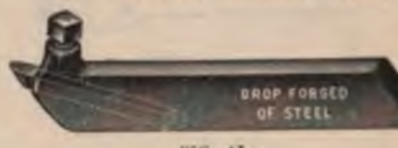


FIG. 41.

A Hugh Hill left-hand cutting-off tool is shown in Fig. 42. In tools of this class the blade is securely clamped in the holder and may be extended an amount just sufficient to make the required depth of cut, thus insuring the maximum strength of blade in every case. The blades are carefully ground to thickness, given the necessary clearance and sharpened by grinding from the end and top. A modification of this tool as shown in Fig. 43 has made a unique and substantial side-cutting tool. These tools are made right and left-hand. The cutting-off tool however, may be had with straight body.

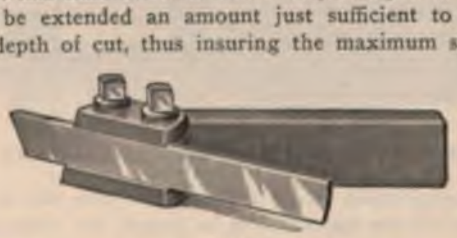


FIG. 42.

The cutting edge of the lathe tool, as shown in Fig. 44, has what we term an angle of clearance A and an angle of rake B. The angle of clearance has the greatest strength value, as the smaller this angle the greater the support given the cutting edge.

For facing, the tool must have some clearance as otherwise the cutting edge is held away from the work. On cylindrical work if set somewhat below the center, it will clear the body of the work but will not properly clear the feed.

The greater the angles of rake and clearance the more acute will be the cutting edge and the finer and smoother the cut. If the edge is too acute, however, it will not stand up to the work properly. The angle of rake has the greatest cutting value, as strength of cutting edge prevents excessive clearance.

A tool may have front rake as in Fig. 44, or side rake as in Fig. 45. It is usual, however, to grind it with both front and side rake as shown in Fig. 46. A tool without rake requires greater force to drive it through the cut as it tears rather than cuts the metal. It does not leave a smooth surface and springs the work unduly.

For the same rate of feed a tool operating upon work of small diameter must have a greater angle of clearance than is necessary when used on work of large diameter, as the same feed gives a greater pitch angle in the former case. This is clearly shown in Fig. 47.

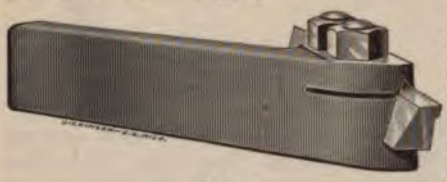


FIG. 43.

It is always desirable when a heavy cut is being taken to have that part of the cutting edge presented to the work as short as the strength and durability of the edge will permit. A straight cutting edge, A Fig. 48, at right angles to the axis of the work presents the shortest possible length of cut, but the delicate point of such a tool will not stand up well. If rounded somewhat as shown at B, we get a cutting length but slightly greater and of a durable form. If the point is too broad as shown at C undue resistance is offered owing to the long line of cutting action.

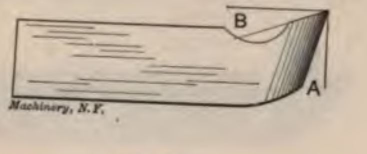


FIG. 44

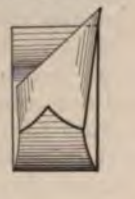


FIG. 45.

That portion of the cutting edge which lies parallel to the axis of the work produces the finish while the portion at right angles to the axis removes the metal. The finishing portion of the cutting edge should be considerably longer than the rate of feed, thus producing a smooth finished surface. If the cut is light and the edge parallel to the axis is long, the tendency for the tool to dip or dig into the work is great and especially so when the angle of clearance is excessive and the cutting edge set high above the center.

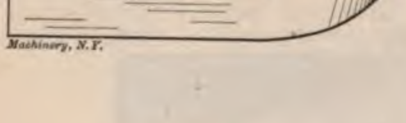


FIG. 46

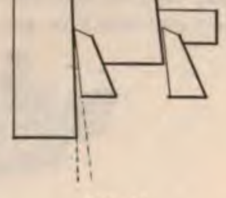


FIG. 47.

In general a tool works best when set for height at or slightly above the center. When above the center any spring in the tool or work causes the tool to dip into the work and leave an untrue surface. Soft spots in the metal or irregular depth of cut will increase this trouble. As the spring comes from the tool post block and points below the cutting edge, setting the tool down to the center of the work reduces but does not overcome this difficulty. If the tool rest was perfectly rigid then a tool having its cutting edge dropped to a line even with the bottom of the tool at point of support would, owing to its own deflection, swing out rather than into the work when set at or below the center. In all cases the tool should be held as firmly as possible and well back in the tool post.

In setting a tool for a heavy cut it should when possible be set raking back rather than ahead as in case of its slipping in the tool post it will swing out of the work rather than into it. This, of course, cannot be done when it is necessary to take the cut close up to the dog or driver.

Cutting-off tools work free and smooth when given an underrate amount of top rake. As with other tools, however, when used on brass they should have no top rake and will frequently be found to work better with a small amount of negative rake.

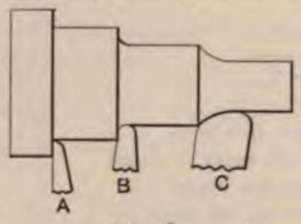


FIG. 48.

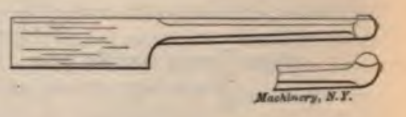


FIG. 49.

The side tool should be given a top rake of from 30° to 40° with a very moderate amount of clearance.

The boring tool as commonly forged from bar steel is shown in Fig. 49. The diameter and length of the stem depend upon the size and depth of the bore in which the tool is to be used. This tool is necessarily a springy one and should, therefore, be as short and heavy as possible, thus requiring a large assortment of sizes for any range of work. The tool shown in Fig. 50 is one of several patent tools which meets the requirements of a first-class boring tool very nicely. The stem which carries a small cutting point of self-hardening steel can be extended for any required depth of bore within the limits of the tool. The same rules for angles of rake and clearance apply to the boring tool as they do to external work.

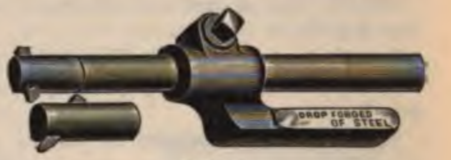


FIG. 50.

A mechanic's success as a lathe hand depends very largely upon the skill and judgment he exercises in the grinding and setting of the cutting tools. They must at all times be kept in proper condition. A dull or improperly formed tool will not do satisfactory work and is frequently the cause of serious injury or accident to the work.

* * *

How long will timber last so as to be safe and reliable for structural purposes, and what is the effect of the weather upon its longevity? This is a question that must depend for its answer upon the climatic conditions and the location of the timber, relative to the ground or water. At a recent meeting of the Association of Railway Superintendents of Bridges and Buildings at Detroit, data were given bearing upon the subject. Long leaf Southern pine leads with records averaging about 15 years when exposed to the weather in bridges located in the Northern States. In Mississippi and Louisiana it is said to last only about eight years. White pine is said to remain sound on an average 10 or 12 years in most sections of the country, though no records are given for the South. Spruce can be depended upon only from 5 to 10 years, and the other timbers like Eastern, Colorado and Northern pine and Oregon fir do about as well as white pine. When protected from the weather all these woods show an ability to last many years. By some who reported they are said to last indefinitely; by others, 40 or 50 years; and in a few cases they are rated with a considerably shorter life, ranging from 14 to 40 years and due, no doubt, to adverse climatic conditions.

* * *

On some of the highway draw-bridges over the Passaic River at Newark, N. J., are notices which contain besides the ordinary instructions to the riding and driving public, an injunction prohibiting the use of "indecent or immoral language" while on these bridges. Whether this restraint on the wicked public while on these bridges is in the interests of good morals or whether the city authorities have discovered injurious stresses on the structures as the result of lurid language is not explained.

## TUMBLER GEARING.

P. J. Connor.

A useful device for the purpose of reversing the motion of driven shafts or disengaging them from the driving mechanism is commonly called tumbler gearing, and it is found frequently in headstocks and aprons of engine lathes, planer elevating gearing and many other parts of machine tools.

The device is very old and it is so exceedingly simple that the only purpose of the writer is to cite a few points in the usual construction of it, and also explain a method of making it. Judging from the number of machines that have been examined in the course of investigation, there seems to have been few attempts made to attain the effect produced in the manner shown in Figs. 1 and 2.

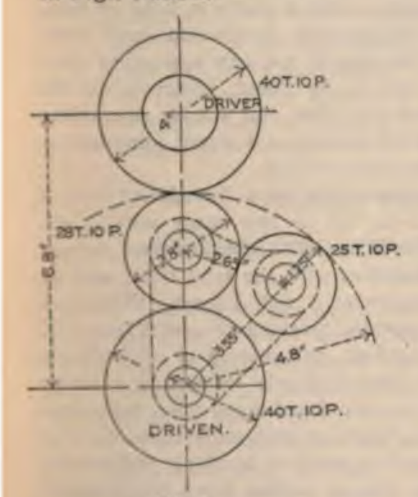
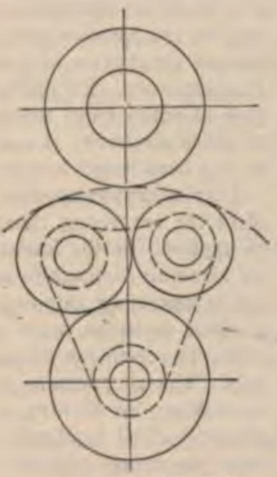


FIG. 1.



Machinery, N. Y.

FIG. 2.

Fig. 1 shows a construction which permits of a free motion of the tumbler frame around its axis and is accomplished, as may be seen from an examination, by making the distance between center of driver and driven gears equal to pitch diameter of large tumbler pinion plus ½ pitch diameters of driver and driven gears.

A difference of three teeth in tumbler pinions will usually be enough to give clearance to both driver and driven gears, and care must be taken to select such diameters as will allow clearance when the tumbler gears are entirely disengaged from the driver. When the center for smallest pinion is selected, it will be necessary to make it such that a circle struck from driven gear center will be tangent to pitch circles of both large and small tumbler pinions.

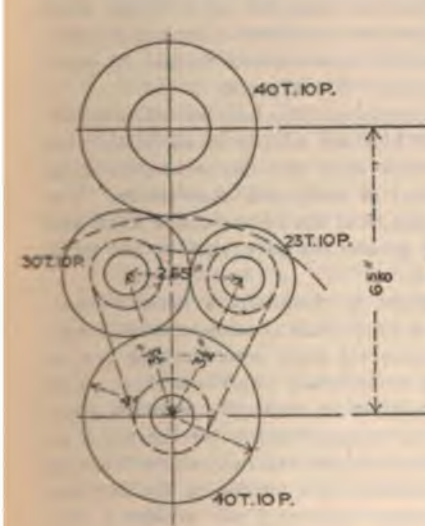
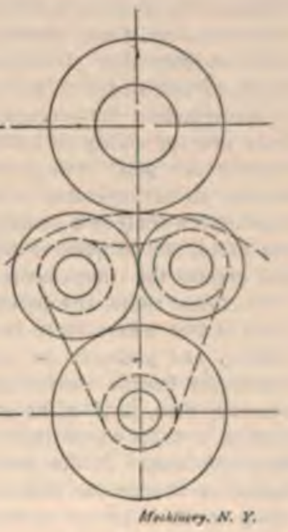


FIG. 3.



Machinery, N. Y.

FIG. 4.

Add diameter of large tumbler pinion to one-half diameter of driven gear, and subtract one half diameter of small tumbler pinion from the radius of the tangent circle to obtain the center distance for driven gear and smallest tumbler pinion. Fig. 2 shows the tumbler in position when both pinions are free from driver.

Fig. 3 and Fig. 4 show the form in which tumbler gears are usually made. The arc of a circle struck from the driven gear center tangent with bottom of driver indicates the fact that it would be impossible to swing them freely on the driven gear center, as noted in Fig. 1, to pass under the driver gear.

The effect produced when the tumbler is thrown into engagement will be either to cause the teeth to lock or else to tend to throw it out, all depending on the direction of motion of the driving gear. It is obvious that the construction which is free from the greatest danger of damage to the gear teeth will be the best, and this is, in the opinion of the writer, secured as shown in Figs. 1 and 2.

The use of tumbler gearing for heavy lathes is not as common now as it was at an earlier period. One prominent concern has discarded them on such machines, and, when reversing the lead screw is necessary, it is effected by a second idler on the quadrant.

Another source of trouble is to be found in the studs on which the tumblers run, as they usually are too small for the strains they must support.

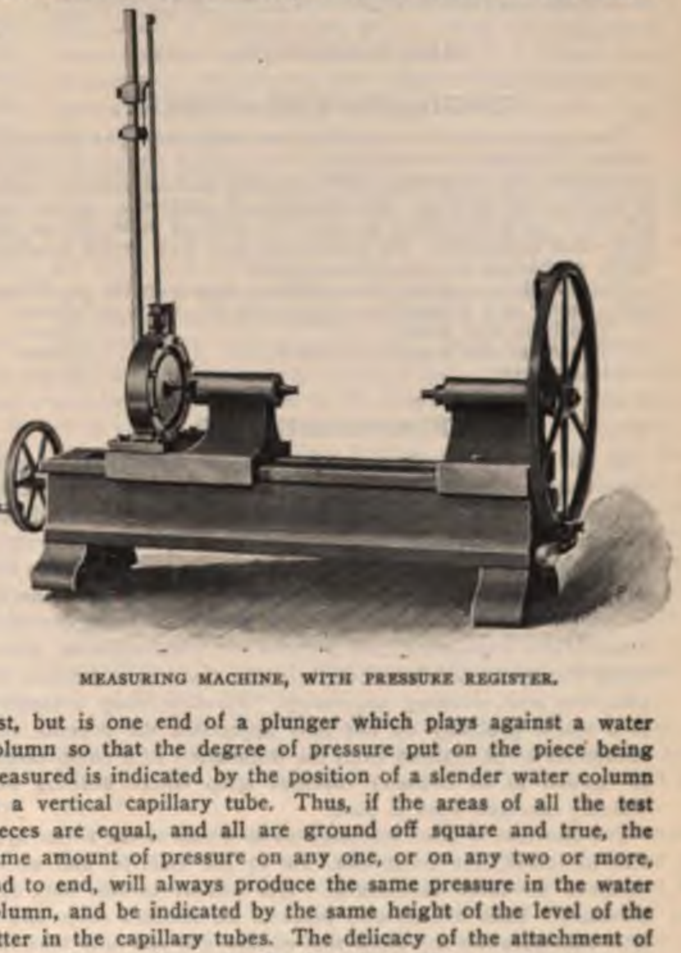
A very good way to make the frame for heavy work is to have it double, thereby having a support for each end of tumbler studs.

* * *

## MEASURING MACHINE ATTACHMENT.

Robert Grimshaw.

In the Reinecker shops at Chemnitz, Saxony, I found a measuring gauge for very fine work which adds to the usual contact arrangement of the "millionth machine," as made popular by Prof. Sweet and others, an arrangement stated to be the invention of one of the brothers Reinecker, by which the amount of pressure between the contracting points can be measured. This insures greater accuracy in measuring as the loose pinch recommended in measuring end to end in such machines varies considerably, so much so that three successive persons measuring the same piece at the same temperature, in one of the ordinary machines, may give three different readings. In the Reinecker machine the contact point at the left-hand end is not fast, but is one end of a plunger which plays against a water column so that the degree of pressure put on the piece being measured is indicated by the position of a slender water column in a vertical capillary tube. Thus, if the areas of all the test pieces are equal, and all are ground off square and true, the same amount of pressure on any one, or on any two or more, end to end, will always produce the same pressure in the water column, and be indicated by the same height of the level of the latter in the capillary tubes. The delicacy of the attachment of this machine is shown by the fact that with a test bar between the contacts the frame of the machine may be sprung enough with the thumb to make the water-level rise and fall an eighth of an inch or more.



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## DECEMBER, 1899.

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The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

| | |
|---|---|
| The IRON AGE, about | 7,000 |
| The AMERICAN MACHINIST, about | 12,000 |
| MACHINERY | 18,500 |

## COMPRESSED AIR.

In this number we have presented a descriptive article upon compressed-air appliances for the shop that will be of interest to those who are contemplating improving their shop facilities. The number of concerns now making air compressors and compressed-air appliances, and the extent of some of the shops engaged upon this work are much greater than would ordinarily be imagined. At the same time the orders for these products come largely from mines and quarries and from industrial plants doing structural and boiler work, where there is a demand for punching and rivetting machinery. Machine shop managers as a whole probably do not fully appreciate the benefits and economies to be realized from the installation of a compressed-air system in an ordinary machine shop where nothing but ordinary machine work is done.

The question is often discussed as to which is the better system to install, the compressed air or the electric, and as to which is the more economical. Our answer is that both are necessary. Each has its own place in the modern shop, and a brief consideration will show that neither one can fully take the place of the other. Take the case of a traveling crane, for example. There have been very good cranes of this kind with compressed air as the motive power, but it involves both coiling up and paying out the hosepipe as the crane travels along the tracks or the carriage travels along the crane girders. It involves, also, reciprocating motors which operate at high speed and are noisy and require considerable care. It is clear that electricity must here take precedence, as the easy transference of the electric current by the trolley and the adoption of the rotary and smooth running motor make it far superior. On the other hand, for hoists about the shop and even for jib cranes of moderate capacity, there is no arrangement yet devised that had quite the simplicity, the convenience and the steady action of the air hoist consisting of a cylinder in which a plunger operates directly upon the chain.

In general it may be said that where a motor is necessary electricity is the better motive power to use. Many rotary motors have been devised for utilizing compressed air, but here as with steam the reciprocating motor is likely to hold its own, and for the same reasons, and any who have heard small compressed air motors of this description run can appreciate their disadvantages. Exceptions are to be found, evidently, in the case of small hand motors for drilling and similar operations to which electricity is not at all adapted and where compressed air has been found to give excellent results.

After a compressed-air system has been introduced into a plant the surprising thing is to find to how many uses it will be applied. In the foundry it is far more effective than rattlers for cleaning castings in connection with the sand blast, and its use in operating chipping hammers is well known. Whenever a repair is to be made upon any machine the workman will prefer to attach the compressed-air drill instead of ratcheting a hole. The air pressure will come in handy for testing castings for leakage, for blowing out core sand and many other purposes; and best of all it affords the means of materially reducing that large percentage of time which is spent in handling and setting up work. There is no better way of cutting down this expense than by the introduction of hoists and plenty of them. As far as punches, hammers and riveters are concerned, it is quite certain that there is no better system for them than the pneumatic system.

* * *

## SEEKING PROMOTION.

In our correspondence column a contributor sets forth some of the disappointments and failures that a mechanic is likely to meet, who has devoted his time to study with the expectation that his efforts at self-improvement will be rewarded with advancement. We do not doubt that the conditions are very much as he finds them. It is probable that in the majority of shops there is a maximum rate for machinist's wages and that if a machinist be ever so well grounded in the fundamental principles of mechanics and be ever so good a workman, he will find difficulty in securing more than the stipulated rate. Under such circumstances it may sometimes be considered a debatable question whether after all it pays to make efforts to add to one's stock of knowledge in his chosen line of work.

Nevertheless, the average machinist who has, we will assume, only average ability to assist him and who lacks all outside influence or "pull," will probably find that the most promising avenue to advancement is that of study and observation. The machinist's trade is a combination of the efforts of the hand and the mind, and in general the greater the part taken by the mind the greater the compensation.

In some shops the machinist is essentially a hand worker. This is true where there is a great deal of semi-automatic machinery and probably no amount of study would enable one to materially benefit himself as a machinist in such a shop. The remedy, then, is to make an effort to eventually secure a position in a shop where there is an opportunity for the mind to help the hand. If the point is finally reached where there is again no chance for improvement as a machinist, the obvious thing to do is to try to become something else besides a machinist. If the mind becomes so trained that it can earn more money acting alone than when acting in connection with the hand, the hand should be abandoned in favor of the mind.

The difficulty, of course, is that it is not always easy to make a change from one shop to another nor to secure advancement commensurate with one's qualifications. But even under such circumstances it cannot be justly said that efforts at self-improvement are to be counted as lost. Evenings spent in study might otherwise be spent in some useless way and they tend to develop the ability and character of the student. Also, there will be no loss, if during the shop hours one tries to become familiar with all the ins and outs of his own and the work around him.

What can the average machinist expect to accomplish who does not try to make himself an all-around man, who can work understandingly? If he does nothing to add to his knowledge he will not be rightly called a machinist—he will be simply a "hand," who works entirely with his hands. Other things being equal, the more knowledge he gains the better machinist he will make; and if he becomes a competent machinist he will then be in a way to become a foreman or secure other promotion if opportunity offers. If he does not become a competent machinist, he can feel reasonably sure that such an opportunity will not offer itself, and that if it does, he will not be able to hold the position. If no opportunity comes, the man who is prepared will still have the satisfaction of being a capable machinist, and we doubt whether after all there is any greater satisfaction to be obtained than is realized in doing intelligent work as a machinist in the shop.

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## NOTES FROM NOTOWN.

### ASKING ADVICE AFTERWARDS—LEARNING A TRADE.

I. Podunk.

Locking the kitchen door after the policeman has eloped with the cook isn't any worse than is done every day in the engineering world, or, perhaps I had better say in the world of investors in engineering products; and when you consider it, this applies to about every other line as well.

I've had two callers the past week, and one was just this kind of a man—only he wasn't sure whether he wanted to lock the door or not—that's what he called to see me about. He was the head of a large grocery firm in Boston, and if any one went to him with a scheme for embalming eggs or making baking powder out of sawdust he would turn him down in a minute—probably wouldn't take time to show him where his plan was weak.

Nevertheless, he was an easy mark for a rotary engine crank, and blew in his hard-earned cash on what is just as much a fake as the aforesaid sawdust baking powder. In other words, he knows groceries, but he doesn't know steam engines, and the only mistake he made was in not coming to see me or some other mechanical chap before going in on the ground floor for preferred stock. He evidently got uneasy about it, and he came to me for advice or consolation, I don't know which. After remarking on the yacht race, or the "trying to race," he said: "Ike, have you ever seen the Seymour rotary engine? If you haven't I'd like to have you look at this and tell me what you think of it," and he drew out his patent papers.

I had seen it, but I let him explain its beauties and economies until he got tired, then he asked what I thought of it. "Mr. Jones," said I, "that engine is as good as lots of rotaries I can show you, but isn't a bit better than a dozen others. None of them are worth a continental for power purposes except in special cases. This one is first cousin to the Haeseler air motor of Philadelphia, only it isn't as good, and Haeseler is too good a mechanic to think of using it for steam power purposes. For pneumatic drills, where you are only competing with hand power, rope or belt transmission, or a small electric motor, the rotary air drill can hold its own, but for power it isn't in it for a minute."

"But it'll go, Ike; I've seen it; and it's so small for a twenty-horse motor that it can't use much steam. Seymour says it is way below the best engines and so does an expert engineer who examined it. Besides, we've been offered $7,000,000 for the State right to build it, and there must be something in it or they wouldn't do that. Guess you must be off this time, Ikey; p'raps you're getting too old to appreciate these new things."

When a man calls you old, even if hair has been a stranger to your head for several seasons, you immediately get riled; but to be called a back number just brings up all the fighting blood you ever had. However, I didn't fight. He was bigger than I and chances for running were not good. So I calmed down to the dignity point and said: "Mr. Jones, anything will go if it has steam enough behind it, but will it go any better or any cheaper than a lot of others?" He didn't know it, but these are almost the identical words I heard Brown say to old Rodnock: "It's hard to build anything that won't go, but buyers must be assured that it will keep on going and use less coal than any other. And it won't do to compare it with another rotary, either; such comparisons are like a burglar putting on a "holier-than-thou" expression when he passes the cell of the chap who is awaiting electrocution. To get his true value he wants to compare himself with the warden, or some one not a criminal; compare with the best there is and see how they stand.

"And, speaking about experts' reports, did you ever see Tom Pray's report on the Bates thermic engine? No! Well, you had better get one. Pray's name probably caused more stock to be sold by that concern to people who knew he was a consulting engineer than could have been sold otherwise, and yet the engine was one of the greatest failures that we have seen for years; and I've been told that Pray had to sue the company for his fee. This was low-lived business, because the wear and tear on a man's conscience in writing a report like that deserves to be paid for, and if an expert's report could make an engine successful that one would certainly have proved the gold mine of modern steam engine building.

"If you've been offered $7,000,000 for State rights, or even for the whole thing, don't rest till you've accepted the offer and got your money. Don't be greedy, Mr. Jones; $7,000,000 would buy you cigars and soda for several days. And if you can't get the whole $7,000,000 I'll advise you to take less—even $7 rather than hold on to your engine. Every dollar you get now is clear gain, for you might just as well count what you've paid in as being thrown away.

"Now, I'm not trying to discourage you in the least, Mr. Jones, but you'll be money ahead by following my suggestions. And it won't be many years before you'll think my advice worth more than that of the experts. I'll send in my bill when that time comes. The better way would have been for you to come to me or somebody else before you put your money into a scheme of this kind. If I went into a wild scheme in the grocery trade, something I know nothing about, and then consulted you afterward, you would probably feel rather disgusted with me. Well, that is exactly what you've done with regard to your rotary engine, and you mustn't wonder if I haven't been very sympathetic. Good day, Mr. Jones." I've probably made an enemy for the time being, and will be reviled as an unprogressive old fogy, but—we shall see.

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One of my nephews wanted to learn to be a mechanical engineer, and wanted my advice. He had a chance to go to a State school for three years, and didn't know whether to do it or to go direct into the shop.

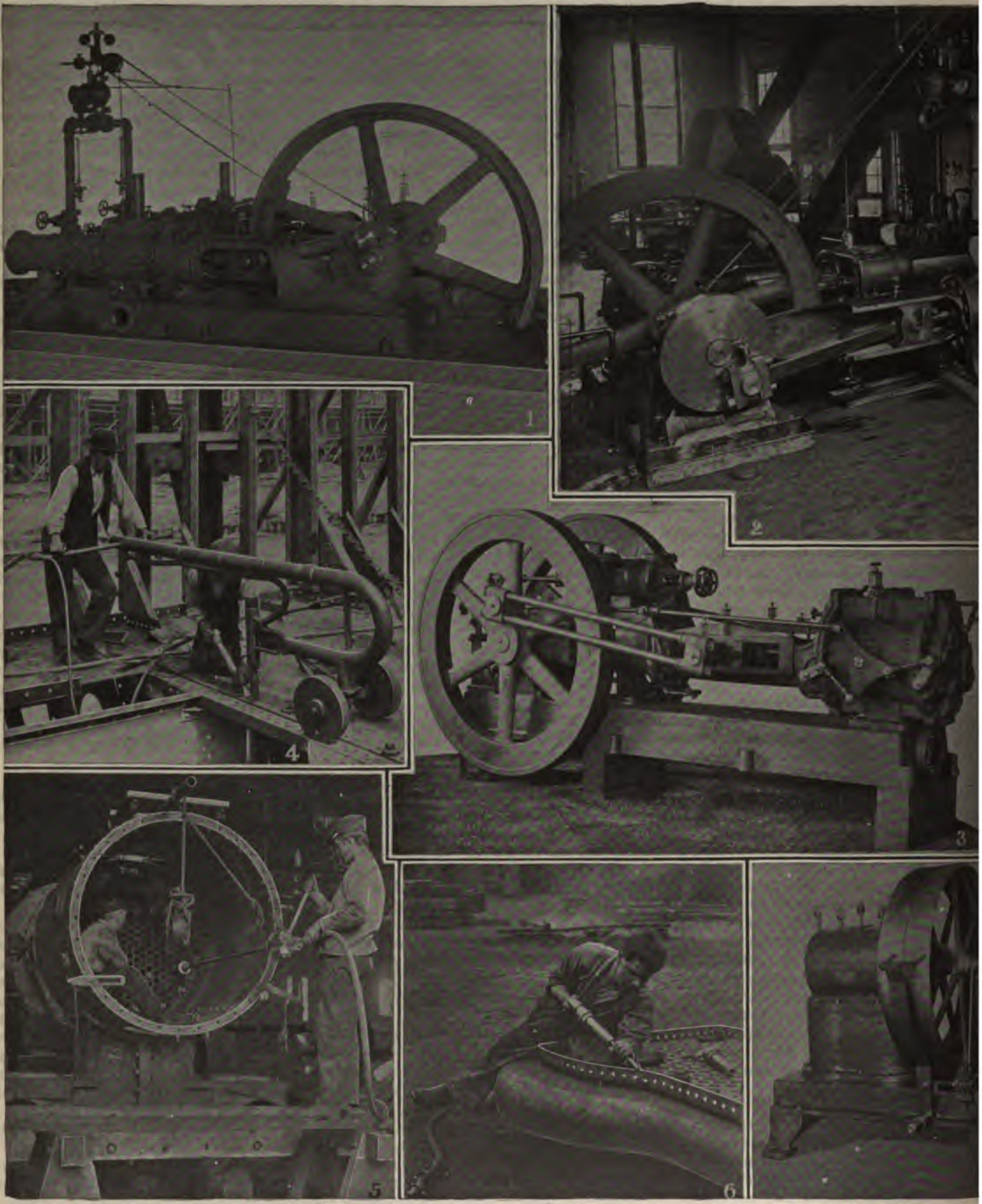
If he had been well fixed financially or his folks had cash enough to see him through, I should have said shop first, college afterward. But he wasn't and I wrote him as follows:

"Dear Nephew: After thinking over your case I should say you had better go right in the shop and stick to it. It will take three years for you to earn enough to take care of yourself, and after that—well, everything depends on yourself. If you have a taste for mechanics, and I think you have, you will like your work, get on well and in time become foreman, and perhaps reach something higher. If you go to college you will, of course, get a good theoretical knowledge, but that alone won't make you a machinist by any means, and you would have to go in the shop before you would be satisfied with yourself or any one else satisfied with you. This means three years more for you to be dependent in a measure on your mother, and you are not the boy to do that, I know.

"If you keep on with your Scranton school work that you took up at my suggestion last spring, you will have a pretty fair theoretical education by the time you are through with your apprenticeship.

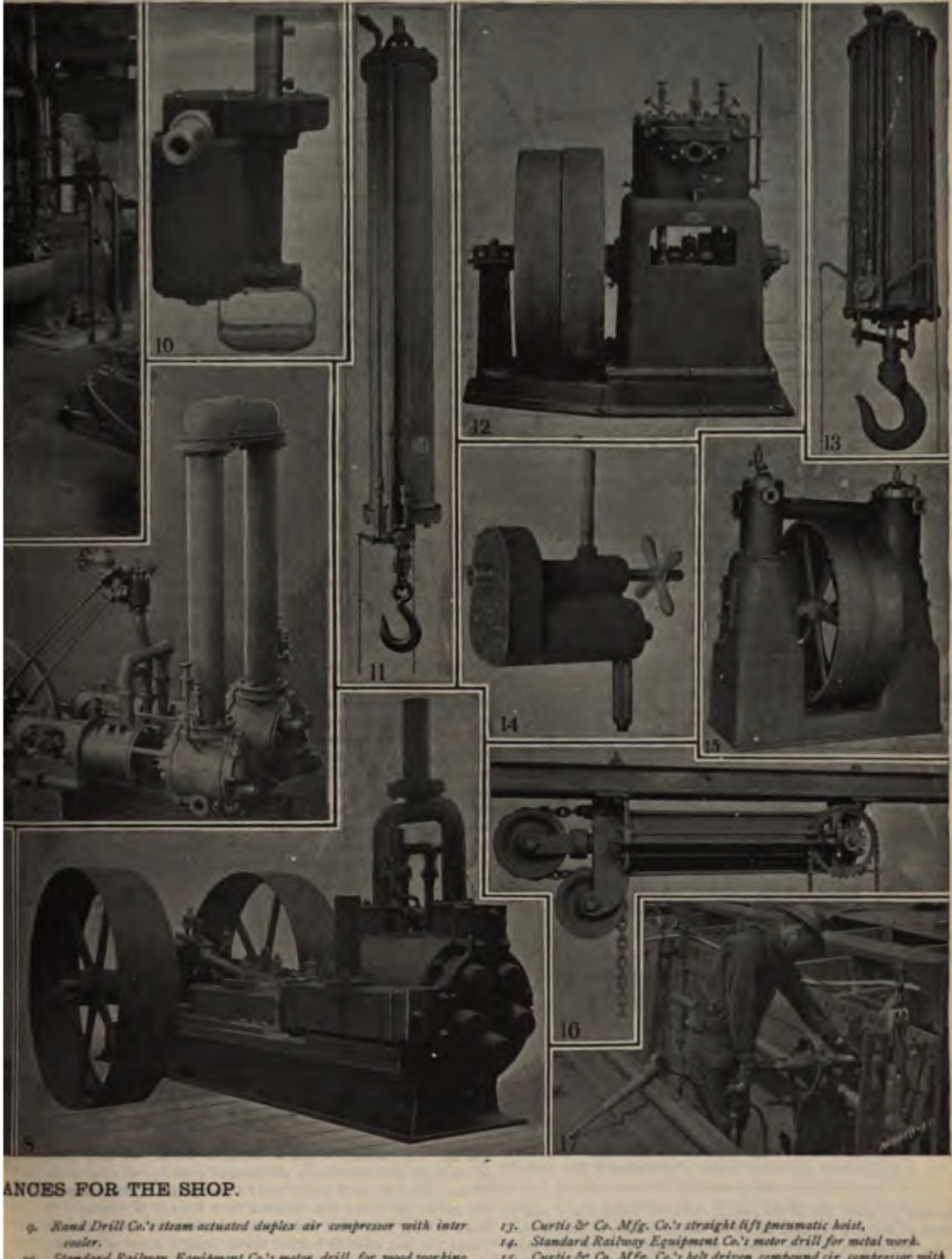
"So, you see,I advise you to go in the shop at once and do your level best. Let me hear from you often, and tell me your troubles, for you'll have them, of course. Perhaps I can offer a few suggestions from time to time, although I haven't a doubt there will be days when you'll wish you had done almost anything else. You'll get over this, though, and, I think, be glad you followed my advice. Your Uncle Ike."

He is in the shop now, and I've heard from him once or twice already.



GROUP OF COMPRESSEI

1. *Stilwell-Bierce and Smith-Vaile steam actuated air compressor.*
2. *Ingersoll-Sargeant direct air compressor at the plant of the Standard Mfg. Co., Allegheny, Pa.*
3. *Stilwell-Bierce and Smith-Vaile air compressor with mechanically operated inlet valves.*
4. *Riveting and chipping with Chicago Pneumatic Tool Co.'s tools.*
5. *Expanding locomotive boiler tubes with Chicago Pneumatic Too Co.'s air driven motor.*
6. *Chipping locomotive boiler flue sheet with Standard Railway Equipment Co.'s pneumatic hammer.*
7. *Pedrick & Ayer's belt driven shop air compressor.*
8. *Clayton Air Compressor Co.'s belt driven air compressor.*



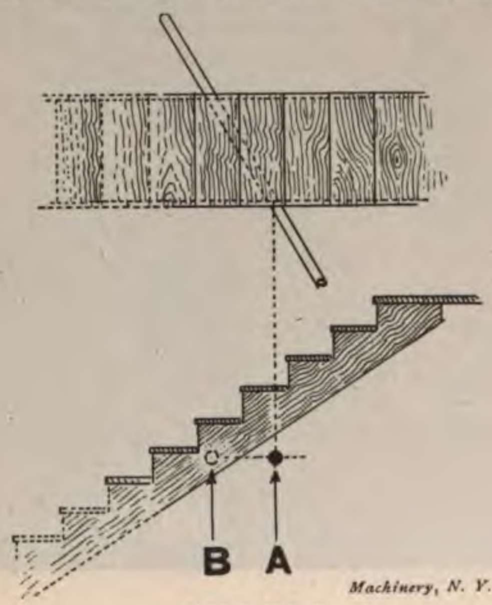
ANCES FOR THE SHOP.

9. *Rand Drill Co.'s steam actuated duplex air compressor with inter cooler.*
10. *Standard Railway Equipment Co.'s motor drill for wood working shops.*
11. *Pedrick & Ayer's straight lift pneumatic hoist.*
12. *Curtis & Co. Mfg. Co.'s belt driven shop air compressor.*
13. *Curtis & Co. Mfg. Co.'s straight lift pneumatic hoist.*
14. *Standard Railway Equipment Co.'s motor drill for metal work.*
15. *Curtis & Co. Mfg. Co.'s belt driven compound cir compressor with inter cooler.*
16. *Curtis & Co. Mfg. Co.'s pneumatic hoist for limited head room.*
17. *Riveting with Boyer hammer attached to Babcock-Gunnell Riveter.*

Machinery New York

### CHAPTER 4.—A LINE OF SHAFTING.

Jones had so much experience out of a contract for a line of shafting as to be worth recording. But first I must tell you about the way he bought his stock. You know that in this age no place is free from the snares and assaults of the commercial traveler, and runners for iron and steel are no exceptions to the customs of the brotherhood. Well, Smith over in Smithboro runs just the same kind of a little shop as does Jones in Jonesville. Smith, however, was never known to pay a bill if he could help it, especially a bill for stock, and he somehow managed to get all the iron and steel he wanted on all the time he needed. One day, Smith happened to have a lathe job on hand which, owing to the quality of the stock, the depth of the cut and the rake of the tool, gave a tremendous chip. The lathe was draped and the floor was carpeted with steel curls, when in came a gentleman representing So-and-So, steel merchants. He picked up a chip from the floor and said, "I see you are using our high-carbon, three-spot diamond steel, wish you would let me take one of the longest of the chips for a sample." Smith consented, telling him he would need about a thousand pounds more of the same size. That afternoon another chap with a grip dropped in and ventured an opinion that those chips came off from his hydro-carbon stock, and he also carried off a ringlet and an order for more steel, and so the good work went on. Every day some new man would come in, firm in the faith that he sold the steel, and at the end of the week Smith had a year's stock of shafting engaged which he had no notion of paying for. What has this to do with Jones? Well, nothing much, only that each of these runners went straight to his shop and uncoiled a steel curl as being a sample of the stock they sold to Smith and told him that he couldn't afford to let his rival use any better stuff than he did, etc. Presently in came the man who actually did handle that brand of steel, and as he opened his grip and took out the inevitable chip, Jones jumped on him and said that he "couldn't look up without seeing one of those fellows bob up like a jack-in-the-box on the end of a long steel chip and declare it to be a sample of their stock. Gave his order yesterday to a chap just because he didn't have any pretty curls with him, and if the present agent didn't clear out he would have him arrested as an imposter; didn't believe the chip was off his stock any more than he believed the brass in his face was off the Maria Teresa."



*Machinery, N. Y.*

FIGS. 1 AND 2.

Jones had lately secured a contract for erecting a new line of shafting in an old mill which involved several crooked turns almost like the Irishman's gun which shot around the corner. He had some notion of employing a draftsman to solve some of the problems, but he abandoned the idea when he found that he would have to pay him "as much to draft as he would to work!" So he said he "would do the drafting himself before he would hire any chap from the kindergarten school and pay him man's wages." Now, the first problem which he ran up against was to run a line of shafting diagonally under a flight of stairs, and the question was to see how high up the shafting could come and still clear the stairs. This seemed easy enough. "All one has to do is to draw a plan view of the stairs with the shafting crossing at the required angle and at the point of crossing project a line down through the elevation until it comes well below the staircase and there you have it" (see A Fig. 2). Somehow it did not occur to Jones that the shafting crossed the stairs on the back side as well as the front, and that a line projected down from that point would cut well into the staircase as shown at B Fig. 2. They turned up shafting pretty much all that winter. Each morning the cub would go out and shovel snow from the pile behind the shop and they would bring in two or three lengths all "whiskered" with frost and icicles. The presence of so much cold metal in the shop kept the temperature down and the exhaust steam which sizzled through a coil in the corner of the shop was unable to compete with it so that everybody was glad when the shafting job was done. The contract price was by weight at so much per pound, hence the necessity of weighing the lot. This seemed a difficult thing to do, for the only scale in the shop was one of only 400 pounds' capacity, whereas some of the pieces weighed nearly twice that amount. Jones stroked his patriarchal beard and reasoned with himself as follows: "I knew a fellar onct what had a girl so big that he couldn't reach round her, and when he hugged her he hugged as fur as he could reach and made a chalk mark, then he began there and hugged again. Now weighin' is a kind of measurin', and what's to hinder my weighin' a shaft up to a certain point and then startin' from there and weighin' the rest. Then the sum of the two must be the weight of the whole!" With this very plausible rea-

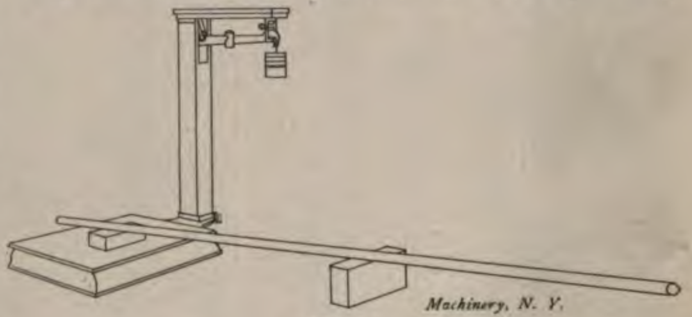

*Machinery, N. Y.*

FIG. 3.

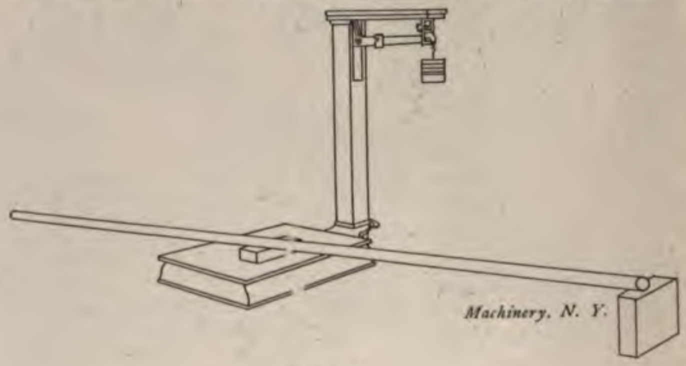

*Machinery, N. Y.*

FIG. 4.

g in mind he arranged his scale and some blocking as n in Fig. 3 and made one draft, weighing, as he supposed, he shaft. Then he moved the shaft along as shown in Fig. weighed the other end, added the two together and charged at amount as being the whole weight of that piece of shaft-

this operation he was not so far out of the way as the re- might intimate. It is no uncommon thing in a railroad for the trainmen to weigh a car longer than the scale by ing first one end and then the other and taking the sum of wo weighings as the weight of the car, but Jones' mistake e readily seen on an examination of the two cuts.

W. H. S.

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## THE WATER WAS TOO STRONG.

connecting rod of a high-speed engine used to drive the no in a hotel at Racine, Wis., broke recently and the piece emained attached to the crank pin knocked a hole through ame of the machine. This is all there was to the accident here were no serious consequences. A local reporter, how- was equal to the emergency, and prepared an "expert" nt for his paper from which Mr. J. W. Fitch, of the Racine ware Co., kindly clipped the following extract for our rs' edification:

he direct cause of the break-down was due to the boiler overworked and water was forced into the cylinderhead the result that the piston rod broke off in the middle and lower hull, and as it was disconnected it was thrown with force across the room. At the time of the break-down gine was making three hundred revolutions a minute and some time before the steam could be shut off. The broken haft was revolving at a rapid rate and striking the floor at turn it made a noise that resembled a cannon explosion he guests in the entire building were startled. However, eam was finally shut off and no damage resulted."

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## OCOMOTIVE PRACTICE IN ENGLAND.

### TEMS OF INTEREST FROM THE HORWICH SHOPS.

f. W. F. M. Goss, of Purdue University, is contributing interesting letters to the "American Engineer" upon some observations during a recent trip abroad. The second of the series refers to a day spent at the shops of the shire and Yorkshire Railway, at Horwich, England. These give employment to 4,000 men and are under the imme- direction of Mr. J. A. F. Aspinall. All repairs are made on 1,400 locomotives and the shops also build new ones s supplying large forgings and the castings and machine required by the different departments of the road. Dyn- for station lighting, electric signalling apparatus, telegraph ments and many other articles which American roads ob- om outside are made here, not to speak of the fact that the has its own rolling mill.

arding the locomotive work, Prof. Goss gives an exceed- interesting description, from which we quote the following:

was at Horwich that I first saw the parts of an English e, both before and during the process of erection. Very machine work goes into the frame. Plates for the sides, h in thickness, two or three feet in width, and thirty feet, in length, are piled and milled to bring the edges to proper e. When thus reduced to the desired form, two plates are to form the sides, the cross-bracing is riveted in, castings e bearing for the axle-box wedges are added, and the frame ctically done.

front of the boiler is supported from the frame and not cylinders, as in American practice. The latter are slipped ween the frames and are bolted to the side-plates, and while removable, they have a very secure place provided for and they certainly have the appearance of being well pro- and quite warm as they nestle close together. The ex- passages are so direct that by looking into the exhaust e may see the slide valve. I was told that an engine com- with broken cylinders could have the old pair removed new pair applied, ready for the road again, in four hours the time of its arrival in the shop.

With the inside connection, the coupling-rod pin on the outside of the main driver is put opposite the inside crank, the wheel crank pin and coupling rod thus serving in part to balance the axle crank and the main rod. A light counterweight in the rim of the main driver is, however, necessary, and while entirely correct, it looks odd at first sight to see the wheel going with the crank and counterbalance on the same side of the center.

But I imagine that the inside-coupled engine, though it has many good points, will not always live even in England, for here, as in America, one manifestation of progress in railroading is a desire for more powerful locomotives. A response must involve larger cylinder volumes, and as no considerable increase over present maximum dimensions is possible under existing practice, the cylinders will in the end come outside of the frames.

Mr. Aspinall has succeeded in securing a high degree of uniformity in his motive power. With 1,400 locomotives he has but three different types, though the first installment of a fourth type is now being put into service. This is for heavy passenger service. As compared with those already described, it presents differences quite similar in character with those which mark recent changes in American practice. Thus, while the volume in cylinders has been increased somewhat, the most significant change is to be seen in the diameter and extent of heating surface of the boiler.

The new engine weighs, with its tender, about 90 tons, and its four coupled wheels are 87 inches in diameter. A four-wheeled truck leads the coupled wheels and a two-wheeled truck follows them. The cylinders are 19 by 26 inches, and are steam-jacketed in barrel and heads. The valve motion, like that of all other engines of the road, is the Joy, in connection with which is a steam reversing gear. The boiler, while only 53 inches in diameter of shell, presents a trifle more than 2,000 feet of heating surface, an increase of about 50 per cent. as compared with the boilers previously used by the road.

The new type of engine is steam jacketed and in speaking of the consideration which lead to this practice Mr. Aspinall explained that the service of his engines involved frequent stopping, and the hilly character of the road permitted considerable drifting without steam, both of these conditions resulting in the cylinders being more or less cooled at frequent intervals. He held that such conditions are not favorable to the compound engine, and argued that jackets, by keeping the cylinders always hot, must operate to diminish the loss arising from the cooling which otherwise occurs when steam is shut off. In response to my suggestion that jackets had been often found inefficient because of imperfect drainage, he replied that he had anticipated that difficulty and had found its perfect solution in carrying the steam supply for the large injector through the jackets, experience having shown that the injector thus supplied gave no trouble whatever.

Another detail of the new engine which was novel to me is the steam reversing gear, though I afterwards found such a mechanism to be not uncommon in English practice. Those who have used it agree that it serves its purpose excellently and is not troublesome in the matter of repairs. In principle it is in every way similar to the starting gear generally employed on various engines. A steam cylinder does the work and a water cylinder prevents shocks and a too rapid motion. As applied by Mr. Aspinall, the two cylinders are placed horizontally one above the other, but the most of those which I saw were in general appearance like a half-sized Westinghouse air pump. The apparatus is placed in a position corresponding to that of the reverse lever quadrant of the American engine. I did not see the apparatus work at Horwich, but an engineer of the Glasgow and Southwestern, whose train was awaiting at a station had evident pleasure in making me acquainted with its operation. By manipulating two small handles he moved the link by a succession of very short steps, from the full-travel position to the center, and back again to full travel. Then he repeated the operation, using longer steps, and a third time by still longer steps, and ended the exhibition by entirely reversing in a single movement, throwing the link first one way, then the other, in rapid succession, all in much less time than it takes to tell it.

# LETTERS UPON PRACTICAL SUBJECTS

## MILLING TROLLEY WHEELS—TURNING LINK BLOCKS.

*Editor* MACHINERY:

I saw a rig for milling trolley wheels the other day, and I think I can "go one better," as the one I saw only handled one wheel at a time. The fixture shown in Figs. 1 and 2 goes on a milling machine-table. Each spindle carries a trolley wheel casting A A, and is driven by a worm-wheel and a worm B, as shown in the end view in an opposite direction from its neighbor. The table is lowered for putting on wheels and then it is raised to the required height to give proper depth to the cut. By spacing the wheel blanks so that they will be a distance apart somewhat less than the diameter of the wheel, the cut can be adjusted nicely, even making allowance for wear on the milling cutters. With the milling cutter D fed in to proper depth, the worm feeds the castings around and one revolution finishes them. The two castings balance the strain on the milling spindle.

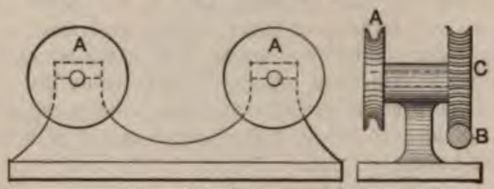

Fig. 1

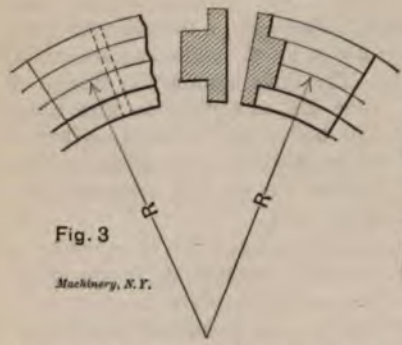

Fig. 3

Machinery, N.Y.

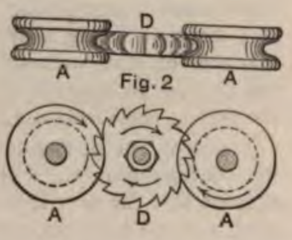

Fig. 2

We had a number of link models to make some time ago, and as the link and link-block have to be made so that they will fit perfectly, it was quite a problem to make them and not have them cost too much. The man who had the work in charge and who designed the models had evidently thought it all out however. He showed us how we could easily mill the links with an end-mill and swing the link in a little fixture of the right radius. For the link block he had an idea that was entirely new to me. He told us to turn up a ring of the right section, sort of a T shape, and of the same radius as the link that is milled as shown in Fig. 3, and then to take two milling saws on an arbor, spaced the same distance apart as the length of the link block and to saw the ring up. This gave us just as many link blocks as the circumference of the ring would allow, and they were all alike and well made, too. FRANK C. HUDSON.

Tombstone, Arizona.

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## TAKES EXCEPTION TO PROPOSED SHAPER SLIDE.

*Editor* MACHINERY:

In your October issue Mr. F. Emerson takes exception to an article of mine published in your September number on the adjustment of the gibs of shaper slides. While I do not wish to prolong a controversy that might become tiresome to your readers, I think a few words more on the subject might be allowed.

Figs. 1 and 2 in Mr. Emerson's article describe nothing new. These forms were known to the ancients and have been discarded long since for the reasons specified in my article. In Fig. 3, however, matters are reversed, and we apparently must look forward to the time when machinists will have to serve an additional apprenticeship as tinsmiths in order to learn to properly adjust their machines. To my way of thinking, any design that tends to place the adjustment of the machine parts out of instant reach of the operator is radically wrong. If the operator is not capable of looking after the proper adjustment of the machinery of which he has charge, he is incompetent. If, as Mr. Emerson states, it is necessary to protect the adjustments of some machines with a table and slide weighing probably twenty or thirty hundred pounds so that the removing and replacing of same would involve considerable expense and annoyance, to simply adjust a screw, I would suggest, as a remedy, that all adjustments be fitted with "Yale" or combination locks, the keys and combinations to be kept in the office and used only when absolutely necessary.

"A little knowledge is a dangerous thing," especially among machine designers. It would seem that some of them are inspired by the evil one when designing machine parts that should be readily accessible in case it is necessary to remove or adjust them. Take, for example, the feed-nuts on machine tools. About 80 per cent. of them become loose owing to the chattering of the cutting tool which, in some instances, causes one turn of lost motion in the feed-screw handle. In most cases, too, they remain loose, for, to reach the screws that fasten them, you will probably have to turn the machine upside down or remove a thirty hundred pound table.

Brooklyn, N. Y. T. B. C.

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## REMARKS BY A MACHINIST.

*Editor* MACHINERY:

When a machinist undertakes to make himself of more value to his employers by studying and acquiring all the information possible in his line of work, he will likely be successful and he certainly should meet with every encouragement. He may by dint of hard work grow to know a great deal more and be able to do far better work than the average workman. He may be worth possibly fifty per cent. more than any other man in the shop where he is employed. Upon realizing this, he will naturally ask for more wages. Unfortunately in nine cases out of ten, he will be met with a stony stare and receive this answer: "There is a limited sum paid a machinist; you are getting that sum and that is all you can expect. We can get all the men we want for less than we are paying you." Now this machinist gets dissatisfied, feels that justice is not being done him and gives up his job. He may have worked in that shop for a number of years, yet he cannot get more than a man who has been there only six months. He goes to another shop where he is a stranger and asks for a job. They ask what he can do and he states his ability which is above the average owing to his praiseworthy efforts to improve himself. He meets with this reply: "No, we don't need as good a man as you are. You are liable to want big wages, to be too independent and harder to handle than a man who knows less." He goes somewhere else and encounters the same thing. Then he asks himself to what purpose he studied and tramped around trying to get experience if he does not stand even as good a show as a poorer and less able man.

I once heard of a machine shop proprietor who circulated mechanical papers among his men with an evident intention of giving them an opportunity to become more experienced, and who remarked: "After a while, these men will want more pay and I shall be pleased to give it to them because they will be worth it." Bless him, I wish there were more like him. Perhaps some will say that the case I have cited is overdrawn, but I can assure them that it is not, as it came within my own observation. There are shops in the United States that would never pay a man over a certain sum, even if he were the best machinist between New York and San Francisco. Still in spite of all this, I would advise machinists, the younger ones particularly, to study and read good mechanical papers. There are plenty of these and they are cheap. Eventually, the man who makes every effort to improve himself and at the same time keeps his eye open for a chance of advancement, will succeed in bettering his position. If a man thoroughly qualified, is at some time offered a good job, he can take it and stand a show of holding it; but if he takes it and is not qualified, he makes a serious mistake, for when his employers discover that he is incompetent and discharge him, he will be worse off than if he had stuck to work which he understood. X. P. RIANTS.

## ANOTHER COLUMN.

r MACHINERY:
ras very much interested in the article entitled "A System of
rn Keeping," by G. H. Hall, which appeared in the October
of MACHINERY. I should like, however, to suggest the
ion of one more column on his sheet. This column is to
in the number of the sheet upon which the drawing of the
rn is to be found. For instance, the lathe bed, No. 20L—1,
d be found on drawing, say, No. A—50. In this way, when
tern is lost or broken, you know immediately where to look
sketch of it in order to replace it. Often, too, I have
l this column useful in looking up some pattern that is very
m used, and whose general appearance I may have for-
n.

R. H. SMITH.

* * *

## ODDS AND ENDS FOR THE SHOP.

r MACHINERY:
en in counterboring for large flat-head screws, particularly
rd brass, the counterbore will chatter badly. This is very
remedied by grinding the counterbore with the least pos-
clearance at the heel. If a very smooth job is wanted, the
ance may be so slight that the tool has to be forced slightly
work in order to cut at all. Counterbores so ground will
nly start holes smooth but will true up those that have bad
er marks. This is an old method often used with planer-
ing tools, and may be applied to any broad cutting edge.

many shops the twist drill has so replaced the flat drill, that
ounger boys seldom if ever have seen the latter; yet when
d piece of steel is to be drilled, a flat drill tempered as hard
will stand and ground with rather small clearance at the
-though enough to cut freely—and as thin at the point as
stand the crushing and twisting action, will generally cut
l that cannot be touched by a twist drill. Kerosene often
s a better lubricant for such work than the heavier oils.

en a twist drill may be ground flat and parallel with the
for a short distance on the front side of the flute, and as it
bles a flat drill somewhat in appearance of the cutting edge,
l also cut harder steel than as usually ground. It should
e ground thinner than usual at the point.

ist drills have their field more largely, however, in the reg-
ine of work, and are not hard enough for such uses as the
t.

ce in a while it is convenient to drill glass, and this may be
by scratching a little cross in which to start the drill, using
y hard flat drill ground thin at the point, a steady but light
and rather slow speed. Benzine is the lubricant. A block
od ought to be used between the glass and drill-press table.

drilling hard steel and other hard substances, the feed should
ong enough to start the cut at once and keep it up, for when
l rides over the surface for a very few revolutions, the edge
rn off, and the work so glazed that cutting action is very
to start again.

llmakers and others call the attention of users to the matter
inning down the points of drills, as they wear shorter and
quently thicker, but, in most shops, this is neglected. If
hinning down the points of drills were always the practice,
ase and rapidity of drilling would be a very great surprise
ny.

dering articles of steel is very common; but it is rather
ge that a good preventative of rusting, after using zinc chlo-
the ordinary soldering "acid," is so little known. It is sim-
dip the work in sal soda solution, the common "soda
" of every shop, after the soldering is done. This also pre-
those rust marks so often found on tools and work one has
soldering when the hands are not dipped in the soda water
bed with a piece of waste wet in the solution.

solution may be cold or warm as convenient. Also in
ing or "sweating" steel it is frequently desirable that the
es of the joint shall not rust. This can be accomplished
ing the acid as is generally done, and by thoroughly tin-
both surfaces, then washing them in sal soda and then in
. This last is very important as solder will not flow well in
esence of sal soda.

r washing off all sal soda the surfaces may be brought to-
r, heated and united; for the solder has already adhered to
el, and the two surfaces of solder will, of course, unite when heated; and if the acid has been well neutralized by the soda, no rusting will occur. A stick is often used for covering the surfaces with acid, but it soon becomes charred and gummy and causes annoyance.

A slate pencil is much better than a stick, and where the work is itself heated, instead of using a copper, a strip of brass may be used to carry the acid and lead it and the solder where desired. The brass even when not tinned at first soon becomes tinned and is very efficient in doing a good job.

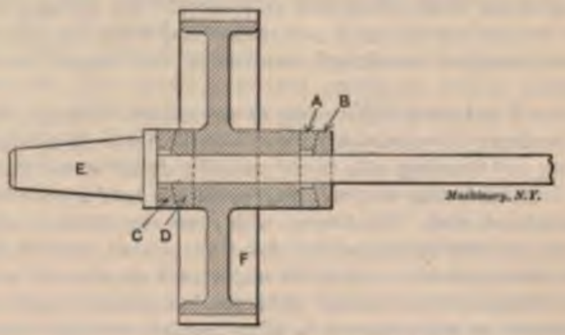
FREDERICK M. BUSH.

* * *

## CUPPED WASHERS FOR HOLDING WORK IN GANGS.

*Editor* MACHINERY:

Here is a device which may perhaps prove of interest to readers of MACHINERY. It is used for holding a gang of gears, or other similar work, true on an arbor without the aid of finished hubs or surfaces for clamping. It saves the expense of these operations and at the same time guarantees true work. It may prove of special interest to those who have to finish work that can be mounted in a gang on an arbor and that does not require that the sides or ends of hubs be squared except for clamping. It consists of cupped washers which lie between the hubs as shown in A, B, C and D in the sketch. The washers are made to adjust themselves to any irregularity on the surface of the hub by reason of the spherical construction without distorting the truth of the work with its bore and to keep the arbor true by giving an equal pressure all around the face of the hub when the nut is set up. The holes in the washers are 1-16" larger than the arbor so as to give them the necessary freedom to adjust themselves.



ARBOR FOR GEAR CUTTING.

I have used these cupped washers successfully on gears, mounting them in gangs of six on an arbor, for cutting the teeth. The hubs of these gears project beyond the rim on one side and the rims of each are 1⅛" wide with forty to eighty 7-pitch teeth. Of course, one set of cupped washers answers for all sizes.

Another device used with success for holding gears while cutting teeth consists of light discs which lie between the gear rims and heavy rigid ones which brace and clamp the rims while the teeth are being cut. A coarse feed can be used without springing the rims forward or the arbor down out of a true line, both of which troubles are sometimes experienced when cutting a gang without discs. Below are a few figures on speeds and feeds of milling cutters that show two methods of practice in different shops. The teeth of a gang of six 120 teeth gears, 7-pitch, were cut, the surface speed of the cutter being 6" per second and the feed of the platen carrying the gears being 1" in one and a half minutes. It required 3.7 days to cut the gang of six gears under these conditions and the cutter was sharpened twice for each set as it would dull before all the teeth were cut. Gangs of six 120 teeth gears can be cut with surface speed of cutter 4" per second and platen feed of 3" per minute in nine hours the cutter being sharpened but once for each gang. Note the result of the two methods: Six gears cut in 37 hours and cutter removed, sharpened and reset and the same number of gears cut in 9 hours, the cutter being sharpened only once. Experience goes to show that a coarse feed with comparatively slow speed of cutter dulls the cutter less rapidly and is more effective on some classes of work than a faster speed with lighter feed.

"JACK."

## ABOUT THOSE EXAMPLES OF MANUAL TRAINING.

*Editor* MACHINERY:

When I wrote the letter on manual training that appeared in the August issue of MACHINERY, I had not the slightest intention of criticising the manual training school as an institution. These schools are doing a great deal of good, and I should be the last to advocate their abolishment. But what I did wish to bring out was the fact that far too many of them are not doing the good they could do. Since reading Mr. Buchanan's "metaphysical" tirade, I have gotten out my August paper and carefully reread my article, and I must say that I can find nothing in it antagonistic to the schools themselves. I did, and I do criticise some of the teachers employed in the schools, and also some of the methods. To be specific, let me quote some passages from my letter: "If a thorough training in this kind of work is impossible under the present school systems, then the systems ought to be changed and something else sacrificed instead of the most important subject in the whole course. * * * If the boy.... is required to work a large number of practical drawing-room problems, he should have no difficulty when he gets into the machine shops. I have * * * in almost every case noticed the same defect—either an inadequate training or a woeful lack of confidence. Both of these faults can and ought to be remedied in the schools."

Do these passages appear antagonistic to the idea of a manual training school? Do they appear as if I doubted that "thoughts are beginning to be recognized as forces?" But perhaps some one of unusual psychological penetration may avow that my mind is in a "negative condition" concerning the manual training teachers.

I know it to be a fact that many of our manual training schools have teachers of metal-work, wood-work, forge and foundry practice, and drawing, who never earned a dollar at the trade in their lives; and what is more, they could not hold a position as journeyman a week. Such men, with their second-hand knowledge of machine-shop practice and management, derived from books, do not seem to realize the importance of practical, everyday problems for the student. The application of the principles of geometry or trigonometry to some problem not only tends to fix the mathematics in the mind, but prepares the mind for similar problems that it will be called on to solve in actual business experience. But "a practical mechanic," of course does not need to be told this.

I do not know whether the manual training schools, as a rule, require all candidates for positions in their work-shops and drawing-room to have had any experience in the trade they are to teach, but I do know that enough of them omit this requirement to warrant my speaking of it. I see no reason why this experience should not be made a necessary and indispensable condition for all such candidates. If a man is not sufficiently interested in the subject that he is going to teach to submit to the drudgery (if he considers it such) of at least a year in a shop or drawing-room, then, I say, the school is better off without him. For in no other way can a man become so familiar with and have such a comprehensive view of machine-shop methods as by actual contact with them.

I think that graduates of many manual training schools do no better in a mechanical line than they would were they to receive their education in the cheaper, ordinary English high school, though this ought not to be the case. Their success is not due to their manual training, but to their general education. Just so, the statistics, excellent in their way, furnished by Mr. Buchanan, do not prove the superiority of the manual training graduate over the man of equal education, but over ordinary workmen; and I take that to mean men with less than a high school education. Statistics, I believe, are not to be had on the point that I wish to make, for they should come, not from the employer, but from the foreman of the work-shop or drawing-room. He is the only one who can tell how much direct good the manual training has done in preparing the student for immediate work. The average wages paid the manual training graduate, during the first six months of his service, would also tend to fix some kind of standard of judgment.

Of course I do not know any of the methods employed by Mr. Buchanan in his teaching, but I will say, that in so far as he neglects to give his students, in one way or another, a thorough drill in actual drawing-room problems, such as, calculating the speed and diameters of pulleys and gears, the weight of irregular bodies in cast iron, wrought iron and steel, the angles for bevel gears, etc., just in so far is his instruction inadequate, and conducive to a lack of confidence in the student. Since it appeared a matter of regret that my address was unknown, I herewith append it.

R. H. SMITH,
29 Benevolent street, Providence, R. I.

* * *

## JIG FOR SHAPING LOCOMOTIVE ROCKER ARMS.

*Editor* MACHINERY:

Having noticed in a number of your recent issues, articles on shapers, perhaps it may not be out of place to give you a sketch and a few words of explanation regarding a unique jig for shaping the round part of the arm of a locomotive rocker.

Originally these arms were milled off, but as the only available miller was a large and expensive machine which could be used to better advantage on other work, the arms were transferred to a slotter. Here, however, trouble was also experienced. The head had to be raised to such a height that only a very short stroke could be obtained. Much time, and consequently money, for time is money in any machine shop, was consumed in adjusting the machine and setting up the work; a slotter is also an expensive machine for that class of work. The jig shown in Fig. 1 was devised and the work was transferred to a shaper. The advantages of this jig are first, its rigidity; second, the ease with which work can be attached; third, only one nut to tighten in "setting up" jig; fourth, the small amount of room taken up by the jig, which can be left on the machine without being in the way of the machinist. All the work done in these shops is piece work, and as the rockers are now finished for fifteen cents per rocker cheaper than before, you can draw your own conclusions regarding the efficiency of this jig.

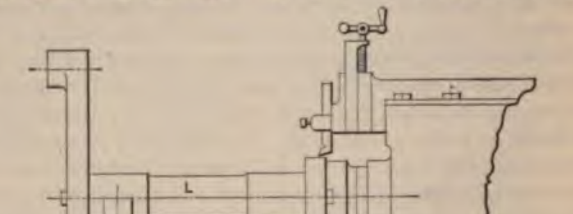


FIG. 1.

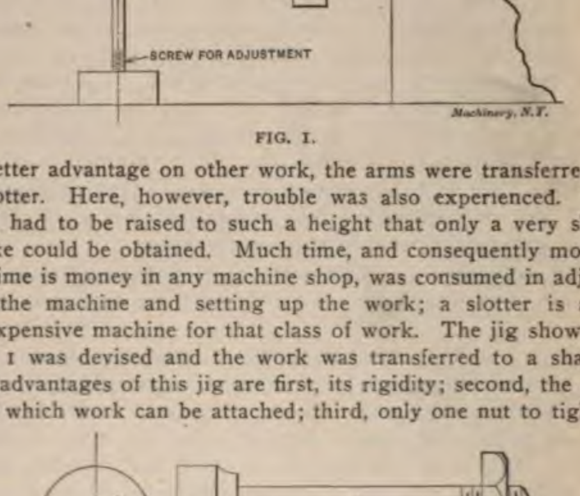


FIG. 2.

The shaper to which this jig is attached has the revolving feed attachment. The spindle A on the jig, Fig. 2, fits into the hole in this feed device and is fastened on the inside by a nut E. In the arm B of the jig and in line with the center of the spindle, a

$\frac{3}{8}$" in diameter and about 1" deep, is bored. This is used ort of female center into which a male center C on the rocker its. This locates the position of the rocker and insures a rmity in the various rockers. On the back of the arm B stud D is fastened, which goes through a hole H in the r F, and which holds it firmly in place. It is not necessary move the carrier to place a new rocker in position. A in place of one of the nuts on the carrier would simplify it nore, but as all the arms are not of the same thickness this possible, or at least not advisable. To support the weight extreme outer end of rocker a light stand is used as shown g. 1 at K.

ig of this kind, as can be readily seen, is very rigid and a " in depth with $\frac{1}{8}$" feed can be readily taken. H. H. D.

* * *

## ONE USE FOR MAGNETISM.

Machinery:

manufacturing a machine we have an operation of doweling machine a small piece, where it is necessary to drill almost a bearing in order to get sufficient stock to support the pin, and also to ream the hole so that the dowel pin will ely.

drill is 3-32" in diameter, the hole, when drilled 9-16" It was necessary to turn the machine over after drilling the o prevent any of the chips getting into the working parts. operation was carried on as follows: The hole was first d as near the bearing as was safe, then the machine (weighbout 30 pounds) was lifted and turned over, so that the would fall out, then placed back on the drill-table and ole reamed to size.

was not many days when the workman said he thought he have to give up the job as he noticed that every time he a machine in the air to clean out the hole, he felt a pain his right arm. Wondered if he had not better see a phy-, fearing he was contracting a cancer.

old him to wait a little while and in the meantime magnetized $\frac{1}{64}$" in diameter smaller than the one he was using. After d drilled a hole the full depth, I told him to carefully brush hips just away from the drill, but not enough to get any of into the parts, then remove the drill and twist the smaller gave him, by hand, in the hole. He was surprised on reng the drill to find nearly all the chips attached to it, leaving ole sufficiently clean so that it could be reamed without the machine from the table. I have heard nothing more the cancer. I trust this may be of interest to some of your rs who may have just such an operation to perform or perone even more difficult. E. C. Thurston.

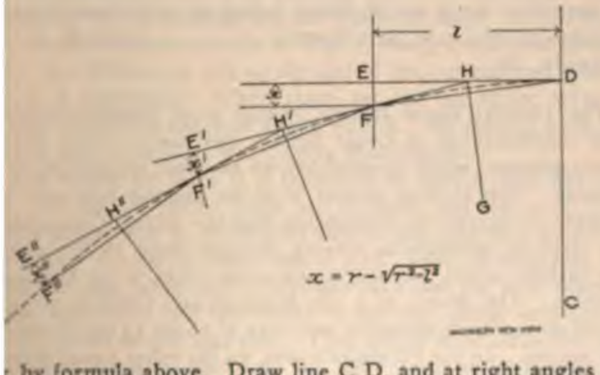
vidence, R. I.

* * *

## TO CONSTRUCT A CURVE BY POINTS.

Machinery:

accompanying diagram and description will be found user laying out a curve having an inaccessible center or one radius is too long to be accommodated on the drawing-. When the radius (r) is given, and any cord (l) is asd, to construct a curve by points proceed as follows: First



by formula above. Draw line C D, and at right angles to line E D = l. Through E draw the perpendicular E F, ake it equal x (marking the first point in the curve) at F. F D and bisect it in G; through G draw the perpendicular intersecting the line E D in H, and through F and H draw ndefinite line H F H' E', making F E' equal to l. Erect the perpendicular E' F' equal to x, and locate F', which is the second point of the curve; proceed in the same manner for other points of the curve desired.

Hokendauqua, Pa. Geo. H. Waltman.

* * *

## TESTING AND ADJUSTING ENGINE LATHES IN GERMANY.

*Editor* Machinery:

We, as a rule, determine a lathe by its height of center over the bed and length between the centers or the whole length of bed.

The old style German lathe with a wide bed and the carriage built way out so as to enable the engineer to turn a piece of work as big as the gap in the bed of the machine allows, has seen its best days, and a good mechanic with a little common sense will not build a tool to turn a needle bar of a sewing machine as well as a locomotive tire.

The main thing in a lathe is that the proportions of headstock and bed, as well as carriage and headstock, correspond with each other, and in order to do a good piece of work, it is absolutely necessary that the alignments be as near as possible.

First, after getting the castings, we rough out the bed on a milling machine with a gang milling cutter. This done, we plane the ways on a planer, then drill the holes in the bed and set the bed on its feet. We then scrape the ways for the carriage and tail stock straight and parallel with each other before touching the carriage at all. The head and tail stock are bored out together in one setting and then, after being driven on a special arbor, they are planed together.

We now fit in the bearing boxes and scrape in the spindle to a good fit. The spindle is ground outside as well as the taper part of the hole inside the spindle. This done, we fit on the carriage to the bed, then put on the headstock and test the latter to see if it is parallel with the bed in the horizontal as well as the vertical plane. This is done in the following manner:

Take a piece of steel pipe about $1\frac{1}{2}$" outside diameter and fit a taper plug in one end and a piece of flat iron in the other; then turn up this bar carefully in a true lathe and grind it the whole length, not allowing any limit in diameter. Put this bar in the spindle and try it at the outer end by setting an indicator, as built by the Brown and Sharpe Mfg. Co., under the bar so that the needle on the indicator will bear against the bar. Then revolve the spindle with the bar inserted and should the test-bar run out, divide the difference between the readings of the indicator by two. Now, put the indicator under the bar at the other end and take the difference of the readings. The difference found between the average readings at the inner and outer ends of the bar gives the amount by 50ths of millimeters, as the graduation on the indicator shows, which the spindle in the headstock is out of line with the ways on the bed. Try in the same manner how the spindle lines up with the bed in a horizontal plane by putting a stop-piece on the base of the indicator and holding this against the edge of the carriage so that the indicator needle touches the test-bar sideways. As the ways on the bed are straight, we do all the correction on the ways in the headstock. After the headstock is scraped to the bed and parallel with it inside a limit of about 0.01 mm. in 18", compare the height of the head and tailstock with the indicator under the test-bar, then take the bar out, put it in the spindle of the tailstock, move the carriage with the indicator attached under the end of the test-bar nearest the spindle, thus finding the difference between the head and tailstock in height. Sideways, use the stop under the indicator and move it back again, testing the alignment as when measuring vertically.

Next, make the ways of the cross-slide square with the spindle in the headstock. To do this, take a taper plug and fasten on the outer end of it a bar of flat iron about $1\frac{1}{2}$" wide and several inches long. This bar is fastened to the plug with a set-screw and is slotted so that it will be adapted to different swings. On the outer end fasten a pointed screw by putting it through a threaded hole in the end of the flat iron piece. Then take a piece of cast iron, square on one side, the other side the same bevel as the cross-slide bed. Move forward the spindle with the plug and bar in place and set the screw so that it just touches the piece held in the ways of the cross-slide. Then turn the spindle backwards and manipulate the same way as on the front end of the machine. The difference in the touch of the screw will show how much the cross-slide is out of square with the spindle. All correction is done in the ways of the carriage.

Frank Salmon,
With Schuchardt & Schutte, Berlin.

* * *

## METHODS FOR CENTERING CYLINDERS FOR FACING AND TURNING.

*Editor* Machinery:

For centering and facing off the ends of large, rough cast cylinders and similar pieces a device was used by one of the prominent firms of this country engaged in the manufacture of heavy machinery, which proved very convenient and reliable.

A cast iron cross was made, as shown in Fig. 1, with an adjusting screw tapped into the end of each of the four arms, the ends of the screws being pointed so as to fit into four corresponding centering holes made in the casting.

In the center of the cross a hole 1½" in diameter and 1½" long was drilled, into which a steel, oil hardened center was fitted, so that there would be no getting out of line on account of wear.

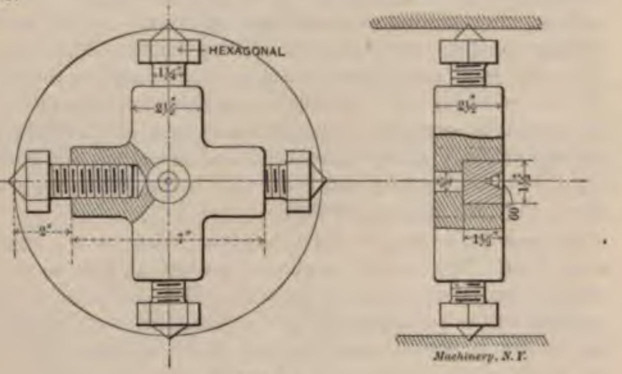


FIG. 1.

A smaller hole was continued through the casting so as to be able to replace the steel center in case it became necessary. These crosses were made so that they would take cylinders with a variation of bore of three inches. For the facing off and turning of cylinders that had been already bored a device as shown in sketch Fig. 2 was used. By means of this device a great deal of time was saved in the centering of the work. The device consists of a cast iron disc turned to a diameter a shade smaller than the size of the bore of the work to be faced or turned. This disc was cored entirely through with the exception of a thin connecting piece on either side.

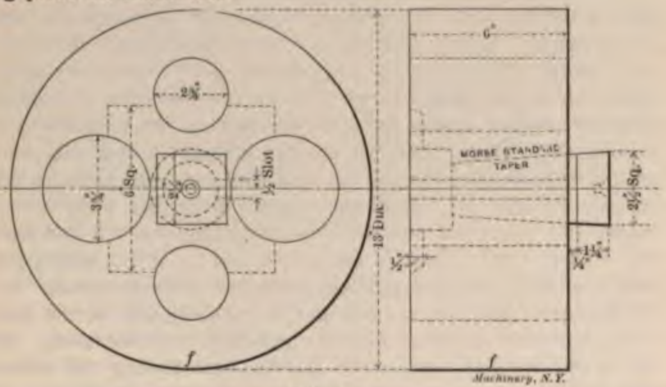


FIG. 2.

In the center of the disc was bored a taper hole, to which was fitted a tool steel center piece, countersunk on one end to receive the center of a lathe.

After the disc had been placed into position in the work, these tapered center pieces were driven into the hole to receive them in the disc, just tight enough to spring the sides of the disc out and thereby holding it firmly in the cylinder.

The ends of the steel center pieces were made square so that a wrench could be applied to remove them from the discs.

The discs were countersunk on the inside face to hold a stick of timber which was placed between the two discs in either end of the cylinder to prevent them from closing in after the work was swung in the lathe.

A. Dunn.

Denver, Colo.

## BELIEVES IN CLOSE FIGURING.

*Editor* Machinery:

In the October, 1899, issue of Machinery there appears an article on the subject of "A Blow-off," by W. H. S., under the heading "Jones Engineering Co., Limited." I desire to state that W. H. S. is slightly wrong in his conclusions, as the accompanying reasons and drawings will show. Fig. 1 is the blow-off before Jones changed it, and Fig. 2 illustrates the changes Jones made. It illustrates the criticisms and also explains why the blow-off "popped" at 80 pounds instead of at 100 pounds.

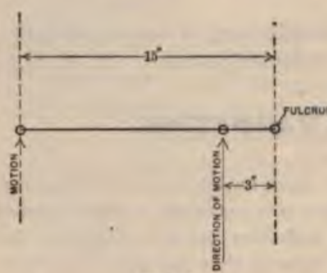


FIG. 1.

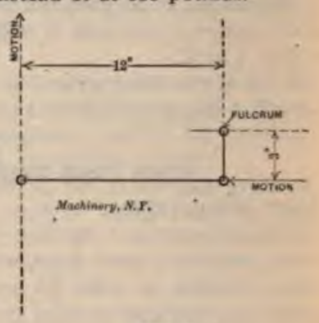


FIG. 2.

I agree with W. H. S. as to the rule by which he reasoned but not as to the application of the same, since the direction of motion is not as his diagram shows, but rather as shown in Fig. 3. The directions of motion of any point in the circumference of a circle is always a tangent to that circle, and a tangent to a circle is always at right angles to the radius at the point of tangency.

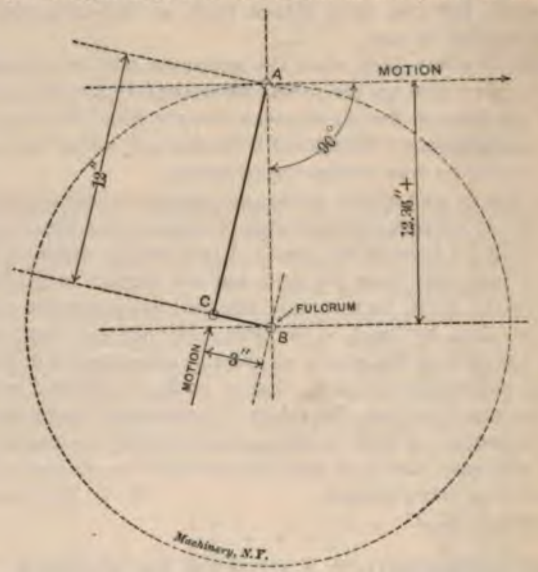


FIG. 3.

In Fig. 3, B is the fulcrum, C the leverage applied, and A the weight. A C is perpendicular to C B, therefore A B is the hypothenuse of a right-angled triangle with a length of 12.36". Thus, we find that the lever, instead of giving an even multiplication of 4 to 1, is in the ratio of 4.12 to 1 or nearly 4⅛.

I am a firm believer in earnest and friendly discussion as it is of interest to many and doubtless brings up many new points and benefits all who take part therein.

James B. Lund.

Austin, Ill.

* * *

The Delaval steam turbine, which is of Swedish origin, is now manufactured in Great Britain, the home of the Parsons steam turbine, which already has an enviable reputation in that country. The Delaval turbine is of the impulse type and has a number of nozzles so constructed that the steam is expanded to the terminal pressure in passing through them to the vanes of the turbine wheel, beyond which point there is no further expansion. The wheel of a 100 horse-power Delaval turbine is about 20 inches in diameter and runs at about 13,000 revolutions per minute. In the Parsons turbine, on the other hand, there is a series of turbine wheels, with guide vanes between. Steam is delivered to the first wheel at boiler pressure and expands a small amount in passing through the first wheel. It then goes through guide vanes to the next wheel and expands a little more in passing through this wheel, and so on, the expansion being by gradual steps as the steam goes from wheel to wheel.

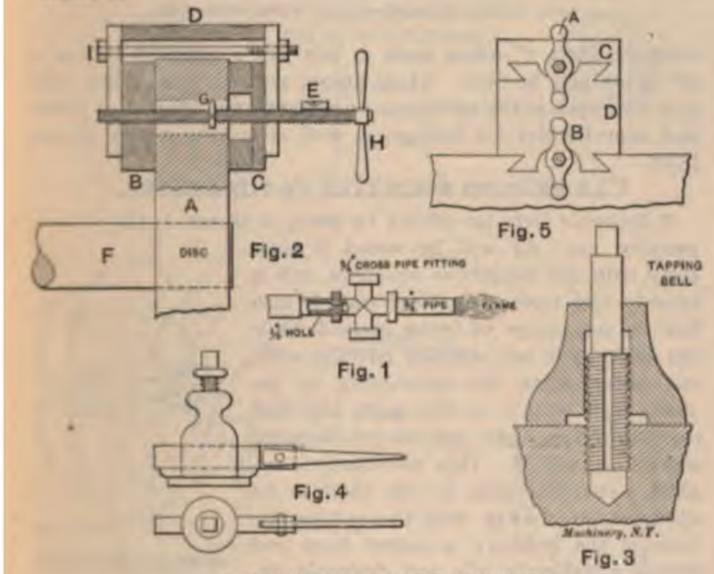
## SHOP KINKS.

### A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

**Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.**

### SOME PENNSYLVANIA SHOP KINKS.

U. P. Lang, of Meadville, Pa., says: I recently had a job of boring out and putting in two crank pins which, after being pressed in, would not remain tight. The pins were 4" in diameter in the crank disc. I rebored the hole and heated the disc by running a hose from a natural gas jet and heating as much as was possible with only a black heat. The gas heater is shown in Fig. 1. I allowed only 4-1000 so as to be able to slip the pins in without sticking. They have been in place over two years and have no appearance of ever working loose. Accompanying this is a rough sketch (Fig. 2) of the tools I used to rebore the disc. This was my own way out of a rather difficult job, but the idea is probably old to most machinists. The boring bar is finely threaded, has the cutter G, and is held in position by the wood blocks B, C and D. By trying level E when the crank was at each center and at the top and adjusting the bar so that it showed the same at all three positions, and was central with the hole, I knew that the bar was parallel with shaft F. The cutter bar was threaded in split block B and a tight fit in block C.



A COLLECTION OF SHOP SCHEMES.

Fig. 3 is the sketch of a handy arrangement for tapping holes. The tendency of the tap is to remain square with the face of the work when supported by the bell-shaped stand. When the tap has been started the bell is slipped off and the tapping finished in the usual way.

I have noticed that very few lathe hands have a pointer for their post. They generally use a pair of inside callipers when they are setting stock for tapers but the device shown in Fig. 4 will be found more convenient. When cutting long threads it is difficult to get a light cut after running the carrriage back. With a double or swivel carriage this can easily be done. When starting a thread keep the handle B, Fig. 5, straight and feed in with handle A. When you get to the end of the cut pull out with B leaving A stationary. When ready for the cut again, bring B straight as before and feed again with A. Be sure to have the slides C and D parallel when using this scheme.

When facing off work if it is desired to take a very fine cut, as in cutting off piston rings for instance, put the slide C at a slight angle with D, cross-feed with B and side-feed with A.

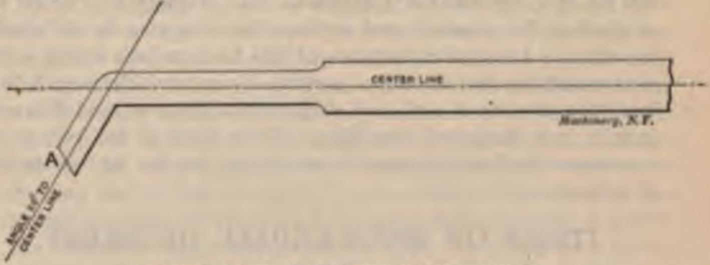
Speaking of piston rings, use a 3-16" wide parting tool for cutting-off and when nearly through take out the tool, insert a narrow side tool, face the inside of the cut, gauge and cut-off with the point of the side tool. This makes both sides true and although it takes longer to do the lathe work, saves double the time when fitting up.

A piston ring is a mighty hard thing to fit just right so as not to be too tight nor too loose. If it be too tight it will do no good; if too loose it will click. To prevent clicking try pening slightly with a light hammer in the middle and near both ends, always pening on the one side of the ring so as to stretch that side longer than the other. This will give the ring a twist or bow, which can be plainly seen if laid on a flat surface. This forms a warped surface, so that when the ring is in position it has a tension sideways which will remain about the same although the ring may wear considerably in the groove.

The way to pene a flat thin ring is on the inside, near one edge. Pening it thus will cause it to spring in the same manner as in the previous case and accomplish the same result.

### AN INSIDE THREAD TOOL.

"E. J. B.," of Dubuque, Iowa, sends a sketch of a handy form of inside threading tool that is easy to make and grind. It can of course be used only in comparatively large holes unless the bent part be very short. As will be noted, the end is bent so that its center line makes an angle of 60° with the center line of the shank. By making it in this manner, it is necessary to grind only the outer side of the point which is often a convenience when the wretched condition of the grinding apparatus in many shops is considered.



EASILY GROUND INSIDE THREAD TOOL.

### VISE JAW FOR HOLDING TAPERED WORK.

Wm. F. Torrey, of Roxbury, Mass., writes that the other day, in going through the shop of a large pump manufacturing company, near Boston, he noticed a shop kink that was new to him. Thinking that perhaps it may be new to some readers of MACHINERY also, he sends a description of it with the accompanying sketch.

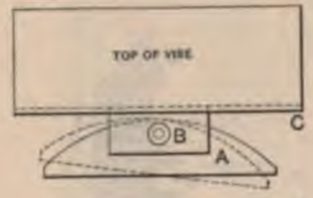


Fig. 1

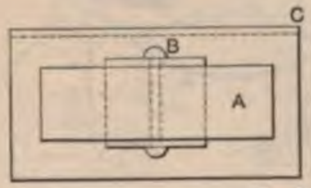


Fig. 2

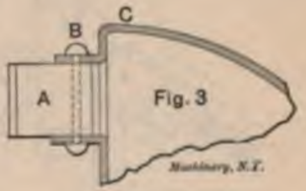
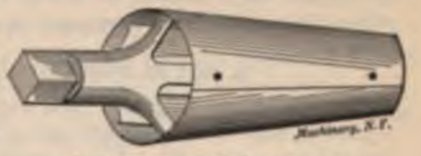


Fig. 3

The device is for holding tapered work in a plain vise and consists of a piece of sheet steel (C) cut and bent to fit the jaws of a vise. In the middle of the vertical side, cuts were made and two ears were bent out to form sides, then a hole was drilled for a rivet (B) to hold the swing jaw (A) in place. The jaw adjusts itself to the taper of the work. The device was used for finishing light work. Fig. 1 is a plan view. Figs. 2 and 3 are side and end views.

### HARDENING TAPS.

L. B. sends in a kink for hardening taps. He says that, some time ago, he had to temper two standard pipe taps, one 2⅛" and the other 2⅜" in diameter and 7" long. The forge he had was rather small for the purpose and the body of the tap was heavy with a very fine thread, so that it was quite difficult to heat thoroughly without burning the teeth. Besides this the work had to be done without delay. He took a piece of tin, wrapped it around the threaded part of the tap and riveted it on both ends as in the sketch, and then heated the tap in the tin case until the flutes cast no shadow, when the tin case was shoved off the



PROTECTIVE SHIELD FOR TAP.

tap. The tap was then allowed to lie in a still fire but was turned at intervals until it became thoroughly heated, when it was dipped the same as any other tool. Some people, L. B. adds, would have used bushings or a piece of pipe instead of tin, but that would have taken much longer. The pipe arrangement is all right when the temper of a tool is to be drawn.

### FROM DOWN IN TEXAS.

Mr. Harry Gunther, of the San Antonio Machine & Supply Co., San Antonio, Texas, mentions in a recent letter that while in a Mexican blacksmith shop he noticed that the blacksmith was making some bridal bits and horse spurs of Norway iron, and punched the holes in the iron while it was cold, just as a blacksmith ordinarily does in hot iron. He says that while this may not be new, he had not appreciated that Norway iron could be worked in this manner, and perhaps the idea may be of benefit to others. As another instance of this he mentions seeing a die sinker making dies for ticket punches by making the punch first and then driving it 1-16-inch deep into a piece of cold Norway iron ⅛-inch thick and then filing off the back of the iron so as to expose the hole, afterwards hardening the die with prussiate of potash.

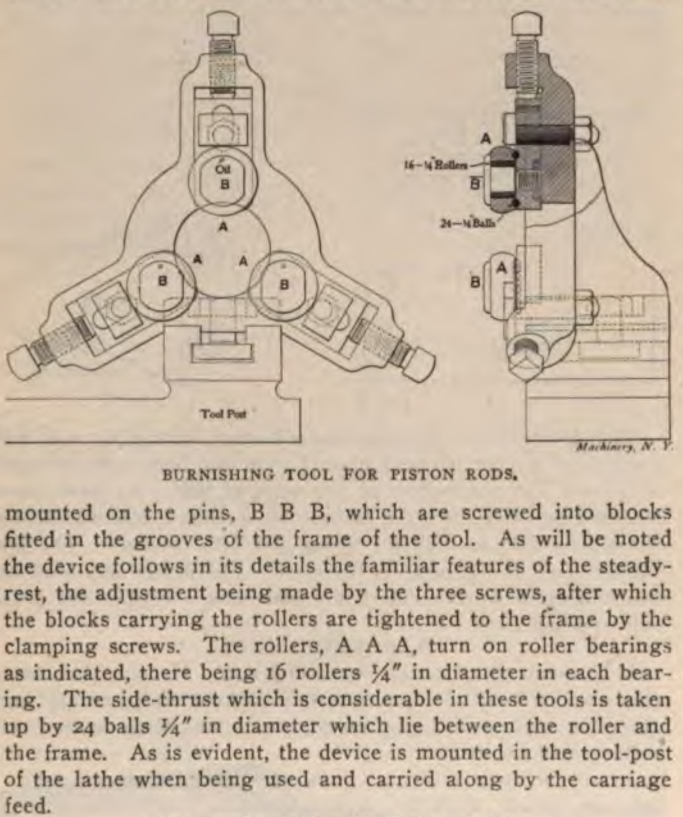
* * *

## ITEMS OF MECHANICAL INTEREST.

### NOTES GLEANED FROM OUR CONTEMPORARIES.

### A PISTON ROD ROLLER.

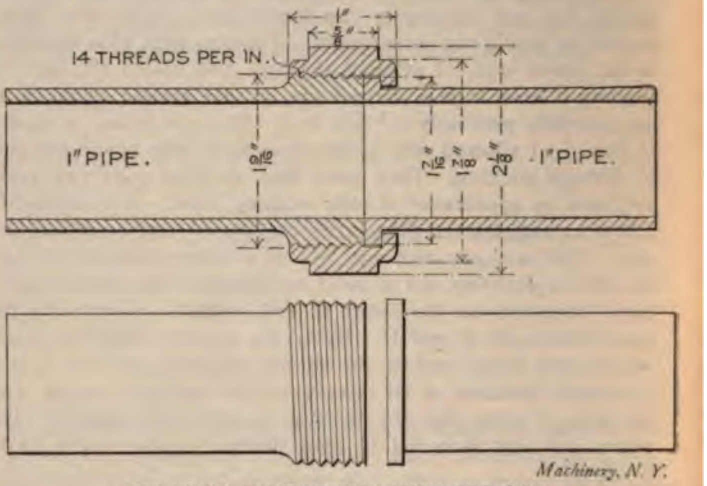
In the July issue of MACHINERY we illustrated three forms of burnishers or rollers that are used extensively in railroad shops for finishing bearings or piston rods and valve stems by a rolling process. As pointed out at that time the practice is becoming very popular and deservedly so on account of the excellence of the surface obtained and the cheapness of the process. "Locomotive Engineering" illustrated one of these burnishers in a recent issue, which is made in the form of a solid steady-rest and intended exclusively for piston rods and similar work which has no section too large to pass through the opening in the device. In the reproduction of the cut, A A A are the rollers mounted on the pins, B B B, which are screwed into blocks fitted in the grooves of the frame of the tool. As will be noted the device follows in its details the familiar features of the steady-rest, the adjustment being made by the three screws, after which the blocks carrying the rollers are tightened to the frame by the clamping screws. The rollers, A A A, turn on roller bearings as indicated, there being 16 rollers ¼" in diameter in each bearing. The side-thrust which is considerable in these tools is taken up by 24 balls ¼" in diameter which lie between the roller and the frame. As is evident, the device is mounted in the tool-post of the lathe when being used and carried along by the carriage feed.



BURNISHING TOOL FOR PISTON RODS.

### A NOVEL FORM OF PIPE UNION.

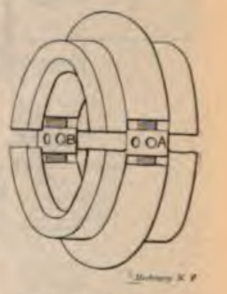
The "American Engineer" recently illustrated and described a form of pipe union that any one will concede to be desirable but not always feasible. It was devised by Mr. Brown, master mechanic of the Pennsylvania railroad shops at Altoona, and as will be gathered from the following description, the union is solid with the pipe, being swaged while hot in dies on a bolt header. In each case the external die is formed to the shape of the finished piece. The internal die consists merely of a plunger of two diameters, the larger representing the larger diameter of the union and the smaller diameter corresponding with the inside diameter of the pipe. The dies are so made that before any upsetting takes place on the pipe the internal die has entered the external die in such a way as to form a closed or solid die. This method permits of the use of the next smaller size of standard union nut than would be used with the standard union. For example, for a 1" union made in this way a standard nut for a ¾" union may be used. These unions are very simple and neat and they possess the advantage of reducing the number of joints and opportunities for leakage, as well as making a very strong joint.



PIPE UNION FORMED SOLID WITH THE PIPE.

### AN ENGLISH SPLIT COLLAR FOR SHAFTS.

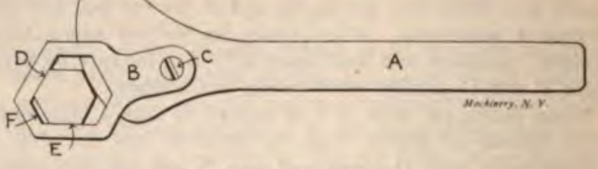
A desirable form for collars on shafts is shown in the accompanying cut. As will be noted it does away with the dangerous set-screw and is entirely free from all projections. It also has the advantage of being applied without difficulty in any ordinary position without necessitating the uncoupling of the shaft, as it is split in two parts and held together by two right- and two left-threaded screws, A and B. This construction enables a vise-like grip on the shaft to be obtained, does away with the scoring effects of the ordinary set-screw form and makes a perfectly safe and desirable device.



SPLIT COLLAR WITHOUT PROJECTIONS.

### AN ADJUSTABLE WRENCH.

The illustration shows the principle of a wrench of English invention which has the feature of limited adjustment, allowing it to accommodate itself to hexagon nuts of various sizes within its range. The piece D has an opening that is of a distorted hexagonal shape, one diameter being greater than that at right angles to it. The piece B is pivoted at C on the handle A which has the cam-shaped end swinging through the slot cut in B. The nut to be turned is thus held between the sides D and E which make an angle of 60 deg. with the side F, and the end of the handle which swings around until the cam-shaped part rests solidly on the side of the nut. The largest nut that can be accommodated, is, of course, limited by the size of the opening in B, while the smallest nut that can be safely turned is one having its sides of a length equal the side F of the part B.



ADJUSTABLE BOX WRENCH.

It would seem that such a wrench must be of very limited value as while it may be strong and reliable, it is necessarily, from the nature of its form and construction, rather awkward and slow in use.

## MACHINE WORK AT SCHENECTADY.

At Schenectady, N. Y., the observing mechanic finds much food for "think" on mechanical subjects, especially at the Schenectady Locomotive Works or the plant of the General Electric Co. Modern tools abound in both places, but there is a distinct lesson to be learned by most of us in each of these shops.

In the locomotive works we find what may be called the extreme amount of machine work on forgings of all kinds and a corresponding decrease of blacksmith work as devoted to finish. At first glance we comment to ourselves on the poor forgings which appear to have been made with very little regard for the final shape of the finished piece. Rod end forgings, for example, bear little resemblance to the shape to which we are accustomed but appear more like A in Fig. 1 than like B, the finished piece. The same is true of the straps and other pieces. This is not, however, due to a lack of good blacksmithing, but to the method employed of getting out forgings as cheaply as possible and of doing practically all the shaping on the machines. Experience has proved this to be the cheaper way of doing this work and it is certain that by the use of machines an amount of metal can be removed in a short time that would open the eyes of some shop men. Milling machines are used for nearly all work of this kind, and vertical and horizontal spindle machines are also much in evidence.

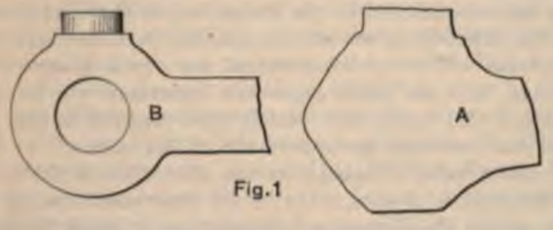


Fig.1

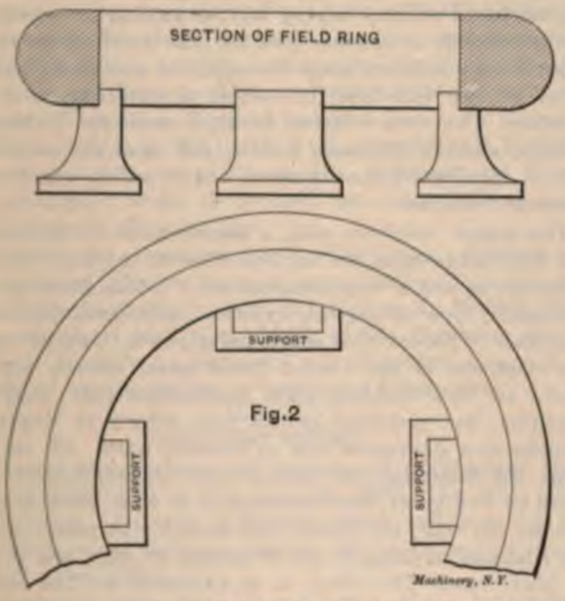


Fig.2

TWO EXAMPLES OF WORK.

The other phase of shop work referred to is found in the General Electric Company's main machine shop in the shape of portable tools. In truth, these are called portable only because of their increased facility for handling heavy tools, some of which weigh several tons. They would hardly have been called portable a few years ago.

In the floor of the shop is a large cast-iron bed plate 20 by 120 feet, thoroughly grouted and bedded on the foundation. On this the large work is placed and the tools are located around it to the best advantage.

During a recent visit we saw several large field rings for generators, some of them 20 feet or more internal diameter. Inside these are slots to be slotted or planed, milled to a dovetail, and holes to be drilled and possibly tapped. The rings are placed on supports similar to those shown in Fig. 2 and the slotter is placed inside. A cable and a snatch block in the floor enable the crane to pull the casting into any desired position and it is surprising how well it can be handled with a little practice. It is no uncommon thing to see two and three tools at work on a single casting, which is enough to make the mechanic of the old school stop and note the great change that has taken place of recent years.

Among the tools found at the shops of this company was a Morton draw-cut shaper with a ram about five feet long, but built with a saddle carrying the ram, the whole arranged on a vertical column. This is another case of bringing tools to the work and this is the first shaper I have seen whose ram moves vertically.

Most of the portable tools were built by Newton, of Philadelphia, and all have independent electric drives. It is well worth a visit to see the methods used and to watch the results.

X. Y. Z.

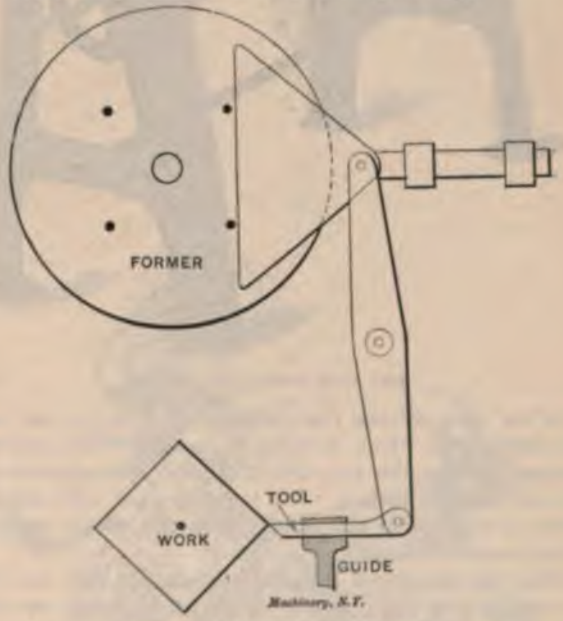
* * *

What a holding up of the hands in horror there would have been ten years ago, says the "Electrical Review" if anybody had suggested electric motors as the prime movers of a powder mill! Yet the art of constructing these machines has advanced so far that the induction motor is to-day considered the safest power machine for such uses. The equipment of the new powder factory of the United States Navy Department is of interest in showing the feeling of safety that has been engendered by the perfection of the electrical transmission and distribution of power. The induction motor has been said to be "as simple as a grindstone." Likewise it is as sparkless as a water-wheel, and in a dangerous place like a powder factory, as safe as a block of ice.

* * *

## A SIMPLE FORMING DEVICE.

At the recent anniversary in commemoration of the seventy-fifth birthday of the Franklin Institute, there were many interesting things said by the various speakers. Among these was a paper by W. F. Durfee, who is so well known as an authority on the history of things mechanical and from a large number of interesting illustrations we reproduce the following which is dated 1752, one hundred and forty-seven years ago.



FORMING DEVICE USED IN 1752.

The work and the former are both turned in unison by gears of chains and the four pins in the forming wheel act on the triangular piece above and so operate the tool. The device is readily understood and is merely useful as a suggestion for other applications.

* * *

### TO BE NOTED.

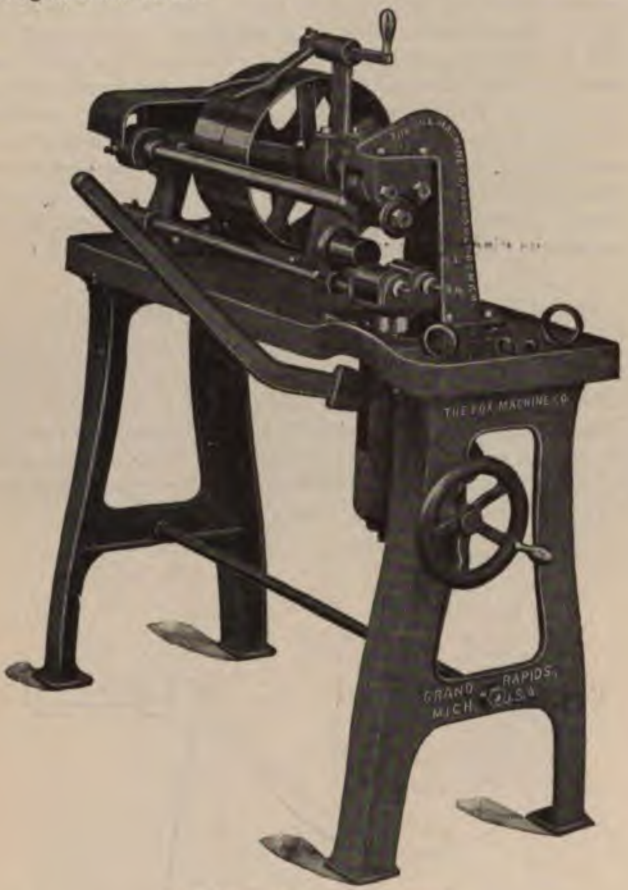
In Prof. VanDervoort's article in the last number it should have been stated that the chuck shown in Fig. 35 is the I. X. L. Independent chuck made by the Westcott Chuck Co., Oneida, N. Y. Inadvertently credit was omitted.

In the description of the Universal Turret Lathe on page 84 of the last number, we stated that the machine had recently been brought out by the Prentiss Tool and Supply Co., of this city. We should have said that the lathe is built by Messrs. Fay and Scott, Dexter, Maine, for The Prentiss Tool and Supply Co.

## PIPE CUTTING MACHINE.

The tube or pipe cutting machine shown in the accompanying illustration has recently been placed on the market by the Fox Machine Co., Grand Rapids, Mich., for cutting pipe from ⅜ to 2½ inches in diameter. It is constructed on the same general principle as their smaller machines, but is built heavy enough to withstand the pressure required in parting heavy tubing.

The lower bearing rolls are hardened steel, large in diameter and are carried in the adjustable bearing block which is elevated and lowered by the hand wheel shown on the front of the machine, motion being transmitted through a pair of bevel gears. The long hand lever seen at the left operates a cam under the plunger which carries the bearing rolls. When the lever is depressed it raises the rolls ⅜" and forces the pipe that is to be cut against the cutter.



FOX PIPE AND TUBE CUTTER.

On the main driving shaft is a hardened sleeve just back of the cutting disc, which in turns bears against two anti-friction bearing rolls at the top and distributes the pressure of the cut over a large surface. The lower bearing rolls can be adjusted to cut pipe of the various diameters within the capacity of the machine.

When the adjustment is made, it brings the pipe just clear of the cutting disc, the pressure on the handle forces the bearing rolls of the pipe against the rotary cutter, quickly separating the tubing, and a piece of ordinary steam pipe one inch in diameter can be cut in ten seconds. It is said that a piece of steam pipe 2½" in diameter can be cut in 30 seconds.

Actual time taken from a machine at the Pope Tube Works showed that 26 cuts were taken in 5 minutes on 1⅛ inch diameter No. 11 B. W. C. soft tubing and the same number in 5½ minutes on 1½ inch hard stock, with records for other sizes in proportion. The machine is heavily geared, with ample driving power and weighs 450 pounds.

* * *

The purpose of the naval engineers of the government is to have the new battleships combine as far as possible the good features of both battleships and cruisers. They will have a speed of 20 knots and will have a belt line of seven inches of the latest armor, which is as effective as 12 inches of the armor plate made a few years ago. They will be provided with triple screws, two of which will be used for ordinary cruising.

## NOTES OF THE MONTH.

### REPORT OF THE BUREAU OF STEAM ENGINEERING.

The annual report of the Chief of the Bureau of Steam Engineering has recently been issued. It contains the usual reports of the naval stations and other divisions of this department, with recommendations for their future successful operation. Of these the most timely is what is said about the new plant now being erected at the Brooklyn navy yard, where the shops were burned last February. Plans have been formulated in detail for new machine shops and commencement of the work has been delayed only because of excessive bids. In the meantime the shop work has been carried on in temporary quarters. An appropriation of $750,000 has been made by Congress for the new shops and when they are finished they will be one of the most complete and efficient plants in the world. Electric driving has been adopted for the shops in view of the advances made in this direction by the most progressive outside establishments, no steam will be used outside of the power house except for heating, and the latest pneumatic apparatus will be installed. The fact that eighty-nine vessels were repaired at this yard the past year indicates the importance of this station.

From a technical standpoint the chief value of the report lies in the records of tests made by the department during the past year and in the discussion presented by Admiral Melville upon the merits of electric driving for the auxiliaries on shipboard. As we publish in another part of this issue an abstract of a paper by the Admiral upon the merits of water-tube boilers for naval use, we will defer the subject of auxiliaries until a later number. The tests referred to were upon the Babcock and Wilcox, and the Niclausse boilers, and upon the machinery of two of the Great Lake steamers, one of which was fitted with automatic stokers.

The report concludes with a statement of the progress that has been made upon the various ships of the navy now under construction and a very complete set of tables showing the displacement, type of engines, cylinder diameters, types and dimensions of boilers, trial speed, horse-power, capacity and present condition of the United States naval vessels, 125 in all. There are now building eight battle-ships, four coast-defense monitors, one protected cruiser (the Albany in England), 16 torpedo-boat destroyers and 23 torpedo boats. Of the battleships, the Kearsarge has had her trial, and reached an average speed of 16.8 knots; the Kentucky is at New York in preparation for her trial; the Illinois will probably be ready next May; the Alabama in January; the Wisconsin in May, and the Maine in May, 1901. The Ohio, it is expected, will be completed shortly after the Maine, and later still will come the Missouri. The monitors will not be completed until the spring of 1901, and most of the torpedo boats and destroyers are either completed or will be within a few months.

### WIRELESS TELEGRAPHY.

Mr. Marconi, who conducted experiments in wireless telegraphy during the yacht races, has performed experiments before a naval board for the United States Government during the past month. The cruiser New York and the battleship Massachusetts were used for the purpose. The former anchored off Navesink, N. J., and the latter proceeded out to sea and tested the effectiveness of the apparatus at long ranges. Messages were exchanged once in ten minutes as the Massachusetts steamed out to sea, and interference messages were also sent by an operator stationed at an instrument located on land, near the shore. The interference messages were successful and rendered the messages between the war ships unintelligible. When no interference messages were sent the transmission between the warships was considered satisfactory, but at a distance of 36 miles the messages failed to reach their destination. Mr. Marconi has now left, ostensibly to assist the British Government in the war at the Transvaal. He claims that he had not received sufficient notice to prepare his instruments for the tests in this country and that he has apparatus that will effectually prevent interference on the part of a third operator when two are communicating between distant points. His system appears to work reasonably well, considering the comparatively short time that he has been experimenting with it, but it remains to be demonstrated that he can prevent interference. One suspicious circumstance is that he prefers not to give a complete demonstration of his interference devices at present, owing to the fact that they are not protected by patents. He asks also that the naval experiments in this country be not considered as a test of the system since the instruments used were of an old type intended only for short distance work.

### JUNIOR M. E. MEETING.

The second local meeting of the Junior Mechanical Engineers was held at the rooms of the A. S. M. E. in this city on the evening of November 7. The paper was upon compound locomotives and was given by Mr. Fred H. Colvin, formerly Editor of MACHINERY and now assistant manager of "Locomotive Engineering." He traced the history of the compound and described the modern types, giving also practical bits of information. The first compound in America was built by Perry & Lay in 1867 at Buffalo. It had four cylinders, two on each side arranged tandem, and was used on the Erie road. Work was done by Anatole Mallet in France as early as 1876 upon a two-cylinder compound. He was the first to use a reducing valve, which, however, was not a success. In 1870 a two-cylinder compound was designed by William Baxter and built by the Remingtons at Ilion, N. Y. It had an intercepting valve in the control of the engineer, but no reducing valve. The Webb compound came next and was built with either three or four cylinders. The high pressure cylinders were connected with the rear drivers and the low pressure by the crank axle with the forward drivers. The two pairs of drivers were not connected. Worsdell in England and Van Borries in Germany brought out engines in 1887 that can be compared with Baxter's. In the United States the Schenectady, Baldwin and Rhode Island locomotive works all brought out compounds at about the same time, in 1890 and 1891.

The paper was illustrated by lantern slides, showing the operation of the different types of compounds and an interesting discussion followed, in which Mr. George L. Fowler, Prof. Hutton and others took part. Much of this discussion was in the nature of criticisms that were not altogether favorable to the details of certain designs of compound locomotives.

### OBITUARY NOTES.

Mr Ottmar Mergenthaler, the inventor of the linotype type-setting machine, died at his home in Baltimore, Md., aged forty-five years. He was of German birth and came to the United States when eighteen years of age, being at that time a watch and clock maker.

The invention and successful completion of the type-setting machine made him famous, as it greatly advanced the art of paper and bookmaking. The linotype is probably the most complicated machine in ordinary, everyday use, and an examination of it cannot but impress one with the fact that its inventor must have possessed extraordinary ingenuity. One of its features which renders the machine a practical success, the wedge justifying device, is not, however, the invention of Mergenthaler, but was purchased at a heavy cost by the company to complete the machine. It is a sad fact that the last five years of this great inventor's life was spent in a hopeless fight with consumption, and, as previously stated, he died at forty-five, or at what should have been the prime of his life.

We note that General Thomas W. Hyde, of the Bath Iron Works, died at Old Point Comfort, Va., on November 14, aged fifty-eight years. After serving honorably in the War of the Rebellion, he leased the Bath Iron Foundry and started business in a limited way, becoming manager in 1888 of the Bath Iron Works, which had been incorporated with the Bath Iron Foundry.

Leonard Ames, head of the Ames Iron Works, and for half a century one of the most prominent and wealthy manufacturers of Northern New York, died at Oswego, N. Y., recently, aged eighty-one years.

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### ADDITION TO THE GLEASON TOOL WORKS.

The Gleason Tool Company, of Rochester, N. Y., have just completed and occupied a substantial three-story addition to their works, 105 by 120 feet. Their ground, which comprises about an acre, is now covered with buildings excepting a small area for light and ventilation, and the plant is conveniently located in the center of the city of Rochester on the Genesee River, from which abundant power is obtained.

All the Gleason family, who comprise the firm, are thorough mechanics, and their inventions, especially in connection with gear cutting, have been of great practical value to manufacturers everywhere, while the success of the company from a financial standpoint has been in a great measure due to the unusual business ability of Miss Kate Gleason, the secretary, who not only learned her trade in the works, but has traveled extensively over this country and Europe introducing their products.

* * *

Mr. James Vose, Manchester, England, writes us that, war having broken out between England and the Transvaal, about 200 men of the Volunteer Royal Engineers employed at the Crewe works have been called for immediate service at the front, working military trains, etc. The government have these men on reserve, giving them about half the pay of regulars while on civilian duty, and being entitled to call them at a few hours' notice for service in the field. The railway company is reserving the positions for the men while away and grants them half pay during their absence. This, it appears to us, shows a very liberal spirit on the part of the management.

* * *

### SHOP TERMS ILLUSTRATED.

Machinery, N. Y.

LOOSE PULLEY.

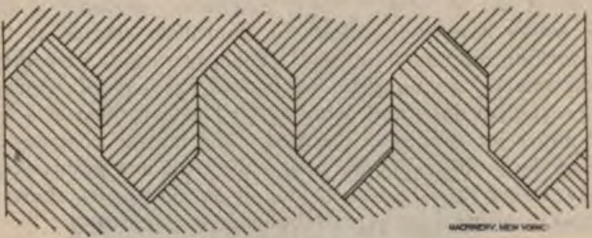
## HOW AND WHY.

### A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

**Give all details and name and address. The latter are for our own convenience and will not be published.**

17.—Draughtsman writes: I should be glad to know what is the usual practice in designing the clutch for a friction geared head-stock. I have noticed that a friction disc is used for the single driving and a toothed clutch for the back gear. This clutch, however, must have suitably formed teeth in order to drive both ways when reversing. The square toothed clutch does not go in easily when running at a fair speed.

A. Toothed clutches are not much used on modern lathes. A good friction clutch will pull all that the belt will pull, or at least all that the belt should be required to pull, on a well-designed head-stock. The only way to make a "powerful friction drive" is to make the friction disc either large in diameter or else fast running. The sketch shows a form of tooth that will enter easily and drive both ways if "Draughtsman" still thinks he must have a toothed clutch.—W. L. C.



CLUTCH TEETH.

18.—M. S. J. says he has a boiler on which he wishes to put a saddle tank, and wishes to know if we can give a formula that will enable him to proportion the tank so that it will have a definite volume.

A. There is no formula that will apply, and we think you would not have good success in attempting to proportion such tanks blindly without understanding the principles of mensuration on which the calculations would have to be based. Procure a good arithmetic and study the subject of mensuration. Then lay out an end view of the boiler and tank as far as you can from the dimensions which you assume, making the drawing to scale. You will then be able to divide the drawing into geometrical figures, of which you can calculate the area or obtain any of the dimensions necessary. If you have some friend who has taken mensuration at school you will do well to have him help you a little in person. A very good course on the subject is contained in Jamieson's elementary text book on the steam engine. We can supply this for $1.40.

Another good book called "Mathematics" is mentioned on page 128.

19.—C. R. L.: 1. If a hole be bored exactly one inch in diameter and a pin turned exactly one inch in diameter, how will they fit? 2. If your calipers just touch the inside of a hole and you then set your outside calipers to them and finally turn a piece so that the outside calipers will touch it when calipering it, how will the pin fit the hole?

A.—A little pressure will be required to force them together, even if the hole and surface of the plug are ground and lapped. This does not mean that the hole would be enlarged nor the plug compressed, for they would not as a whole. The resistance would be caused by the minute irregularities rubbing over each other, producing friction. If friction and adhesion could be eliminated, the parts would go together perfectly. Practically, it would trouble most mechanics to fit together a ring and plug gauge with the latter .0001 inch smaller than the former. 2. This question appears to us to be very much like the other. Assuming no springing nor variation from temperature, they would theoretically be of the same size. Practically their relative sizes would depend upon the man.

20.—E. M. S.: 1. Please inform me as to the most practical method for cutting two, three or four threads to the inch. 2. Also, would you kindly explain a system of running the carriage back by hand in screw-cutting and catching the thread in even numbers or fractions.

A.—It must be remembered that in double, triple and quadruple threaded screws the pitch of the screw is not the distance from thread to thread, but from a point on one thread to the corresponding point on the same thread after it has completed one turn, measured parallel to the axis of the screw. Thus, in a double-threaded screw of one-inch pitch it would measure one-half inch from thread to thread, but the lathe gearing must be set to cut only one thread per inch. To cut a triple screw, with one-half inch from thread to thread, the lathe must be geared to cut a thread in 1½ inches; and for a quadruple thread, one in two inches. After completing one thread the carriage must be moved along, independent of the screw being cut, one-half, one-third, or one-quarter the distance between the spirals of the first thread. Some may prefer to do this by throwing out the half-nut and moving the carriage into position for the next thread by hand and others may prefer to drop out the intermediate change gear and turn the lead screw the proportionate number of turns required to move the carriage the necessary distance. 2. Methods of catching the threads were fully explained on page 287 of the May, 1899, issue, to which we will refer you.

21.—A. J.: 1. Would phosphor bronze or brass connections be as strong for motor carriage work as drop forgings? It would be quite an expense for me to obtain drop forgings and I wish to obtain something of the sort. 2. Can you give me the address of any firm making vaporizers for gas engines?

A. The brass would be decidedly inferior. Any first-class brass foundry, however, should be able to make you bronze castings that would be satisfactory. They would have to be heavier than the drop forgings and there would always be the danger of unsound metal, due to blow holes and impurities, but many bronzes have a tensile strength equal to that of mild steel. Making all due allowances, we think you would be safe in considering average castings of good bronze to have one-third the strength of steel or 20,000 to 25,000 pounds per square inch. 2. Nearly all manufacturers of gasoline engines make vaporizers or carburetters. You will find their advertisements in the various technical papers and in the treatise on Gas, Gasoline and Oil Engines, by Hiscox, price $2.50, is a long list of manufacturers as well as a chapter devoted to carburetters. This book would probably help you.

22.—T. H. G.: Kindly tell me how many foot-pounds of work are equivalent to the number of thermal units required to raise 42 pounds of water at 319 deg. Fahr. to steam at 330 deg., the steam being saturated.

A.—We find by referring to the steam tables that one pound of water at 319 deg. contains 286 thermal units and that one pound of steam at 330 deg. contains 1182.6 thermal units. The difference, 893.6, is the number of thermal units necessary to convert one pound of water to steam at the higher temperature. This multiplied by 42 pounds and again by 778, the mechanical equivalent of heat, gives 29,199,277 as the number of foot-pounds of work corresponding.

23.—Z.: It is my impression that in marine practice the boiler feed water is taken mostly from the hot well and that the evaporators are called upon only to make up the loss due to leakage. If this is correct, I would like to know what means are adopted to separate the oil from the exhaust steam.

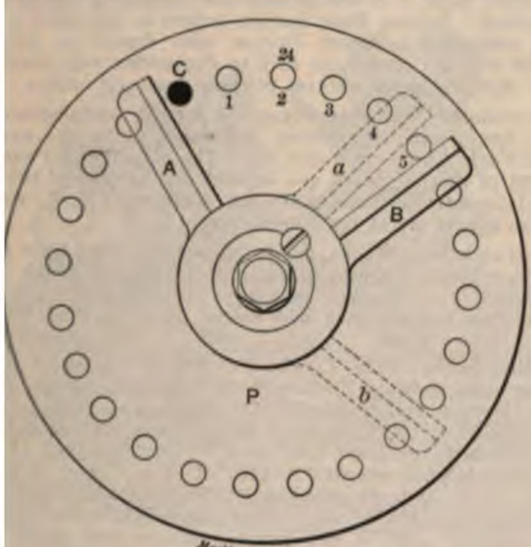
A.—Generally there is no provision for this. With evaporators to supply the deficiency of water the boilers can be blown down occasionally, and if a good quality of oil is used and only a reasonable quantity, the results are not serious. Oil separators could be used, but experiments show that they cannot in general be depended upon to extract more than 50 per cent. of the oil. Filters are also available. At a meeting of the Institution of Marine Engineers held in England last October this question was discussed at length and the opinion was expressed that neither separators nor filters would attain much success in marine engineering. If any readers who have had experience in marine work can give further information we shall be glad to receive it.

24.—S. A.: Will you kindly give me some information about spacing work such as gears, taps, reamers, etc., on the milling machine. I have an index table, but do not understand it. It is divided into columns, the first of which reads at the top, "No. of Teeth"; the second has a heading reading "Circle"; the next, "Turns," and the last, "Holes."

A.—This index table is to assist you to use the dividing head of the index centers with which we presume your machine is ed. If you will examine the index head, you will find that in index plate in which there are series of holes ranged in Each circle is stamped showing the number of holes contains. There is also an index arm carrying a spring it can be adjusted to fit into any hole in the disc. To n spacing there is also a sector which has two arms or , as shown in the sketch at A and B. To illustrate the use table, suppose you find the following numbers under the it headings:

| No. of Teeth. | Circle. | Turns. | Holes. |
|---|---|---|---|
| 2 | A ny | 20 | — |
| 3 | 18 | 13 | 6 |

first line means that when your work is mounted between ex centers you can cut two grooves or teeth, one on each the piece of work, by turning the index arm 20 times, regard to any particular circle of holes. The second set es means that to make three equidistant spaces you must he circle marked 18 and adjust the spring pin of the index that it will have the correct radius to fit into the holes of cle. Next, give the arm thirteen turns and then move it ix holes further. This operation must be repeated every is wanted to space the work. To show the use of the suppose you want to space off five holes on the index ich time on a 24 circle. It would cause some trouble to count these five holes each time and so we set the arms ector just six holes apart. The first hole C is not counted of the five holes that is to be spaced, because there must be one hole for the pin to occupy and if the sector arms holes apart, this will leave five holes for the pin to be ed each time. After the pin and dividing arm have been ahead to hole 5, the sector is advanced to the dotted posi- it is ready to guide the index pin in spacing off five more You will find this and many other matters pertaining to ling machine explained much more fully in the books ie milling machine published by the Brown & Sharpe cturing Company, Providence, R. I., and the Cincinnati Machine Company, Cincinnati, Ohio.



Machinery, N.Y.

INDEX PLATE.

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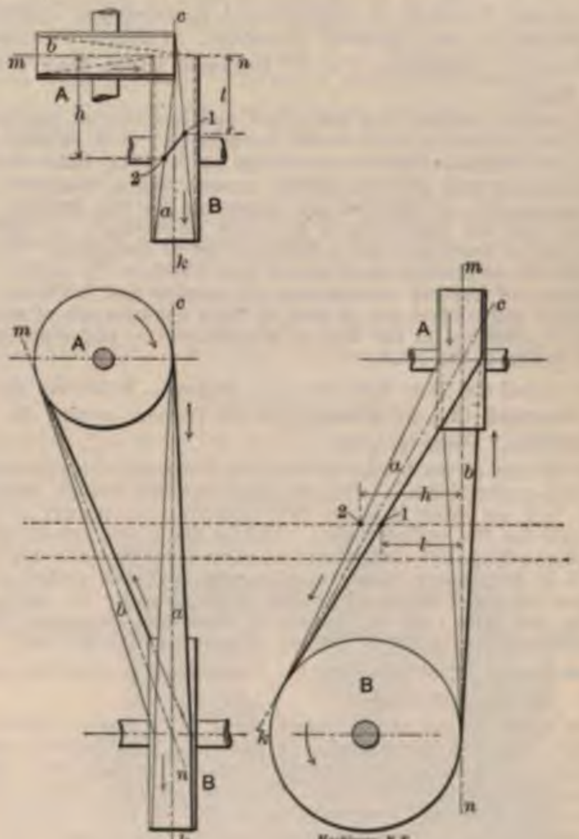
H. E. F.: I enclose a rough sketch of a quarter turn ve and will thank you to inform me as to the best way to the belt holes in the floor so as to conform to the twist belt.

he sketch furnished by H. E. F. shows the quarter turn sing through two floors and gives all dimensions neces- locating the pulleys and shafting. It is not feasible for tempt to furnish complete solutions with dimensions to is requiring so much work as this one, and we there- sent below directions for working it out, which, we think, ully followed, will give results nearly enough correct. iplicity we show only one floor. It is understood, of that a quarter-turn, or in fact any belt must be delivered central plane of the pulley which it approaches; that a belt leaves a pulley, the center line of the belt must be entral plane of the next pulley and at right angles to its shaft. The sketch shows a quarter turn belt with the two sides of the belt leading on to the pulleys in this way. The upper view is a plan and the two others are as one would see the two pulleys and the belts in looking first at the end of the upper shaft and then at the end of the lower shaft. To avoid confusion the corresponding parts, a and b, of the belt are marked in each view and the pulleys are marked A and B. The central lines mn and ck of the two pulleys furnish the basis lines from which to measure and these can be easily laid out on the floor by the aid of the drawing and plumb line. In the two other views the vertical and slanting projections of lines mn and ck are shown and lettered to correspond with the plan view, but for our purpose the vertical lines only are necessary. Now, referring to the right-hand view, we see that one edge of side "a" of the belt passes through the top of the floor at point 1 and that this point is at a distance l from the vertical line mn. Return to the top view and measure down from the horizontal projection of line mn, marking the point 1 on the right-hand edge of the belt equal to a distance l from line mn. Again, in the right-hand view, we find point 2 of the other edge of the same part of the belt to be at a distance h from the vertical line mn and transferring this distance to the plan view we get point 2 on the other edge of the belt at a distance h from the horizontal projection mn. Connecting points 1 and 2, the plan view gives the location of the top of the hole in the floor and a similar process will give the location of the hole on the lower side of the floor.



Machinery, N.Y.

LOCATING BELT HOLES IN FLOOR.

Now, for side "o" of the belt we must take the measurements from line ck in the left-hand view and transfer the measurements to the top view, using this time line ck as a base line instead of line mn. This method of solution depends upon the accuracy of the drawing and is open to the objection that it is not easy to determine at just what points the belt leaves the pulleys. Where the length of the belt is long compared with the diameters of the pulleys, however, this will not produce a serious error and it will probably answer to assume that the belt leaves in each case at the center line of the pulley.

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In reply to "A. H.," question 12, in the last number, who inquired about engines for a 40-foot launch, Mr. Henry Moore, 7 Woodruff Place, Auburn, N. Y., writes that he has engine castings suitable for a boat of this description, and we presume he will be glad to furnish information about them if desired.

## FRESH FROM THE PRESS.

Jim Skeevers' Object Lessons, by John A. Hill. A book of 157 pages on railroading for railroad men. Published by the American Machinist Press, New York. Price $1.00.

This book is a reprint of the humorous and instructive sketches that appeared a few years ago in the "Locomotive Engineering" and are in a measure to railroad men what Chordal's letters were to machinists. Probably they also did as much in making the former journal popular with railroad men as Chordal's Letters did for the "American Machinist" amongst mechanics. The sketches tell in an interesting manner the trials and tribulations "Jim Skeevers" met in working his way from a freight engineer to superintendent of motive power on a mythical railroad which probably would not be so very mythical if the true names of men and places were given. The absurdities of the false economy practiced by many railroad officials are well shown by the inimitable "object lesson" of the doughty Skeever, and the life of a railroad man is portrayed as can only be done by one well familiar with both the pen and all the phases of that peculiar business. The only unfavorable criticism we have to offer is that in the scheme of the book the author has seen fit to omit the sketches that accompanied the original text. Jim Skeevers' method of cylinder and frame fastenings is well worth reproduction by more than the printed description, as is also his method of connecting the exhaust pipe to the top of the steam chest cover and allowing the exhaust to escape in nearly a straight path. In the latter improvement (?) many railroad men will recognize an old friend which has probably been invented scores of times by the would-be improvers of the locomotive, and it thus makes a double-barreled "object lesson" in more ways than one.

Hendricks' Directory of Architectural, Engineering, Contracting, Mechanical and kindred industries. Published annually by Samuel E. Hendricks Co., 61 Beekman street, New York. Price $5.00.

This work contains over 900 pages and has lists of manufacturers and dealers in the branches mentioned. It is valuable as a buyers' reference book containing, as it does, lists of the manufacturers and dealers related to everything employed in the manufacture of material and apparatus for the leading industries. At the beginning is an index of contents, an alphabetical list of architects and a classified list of architects. There is a list of carpenters, contractors and builders, by states; of engineers; of heating contractors; of masons and builders; of gas fitters and roofers and of men in other departments of work. These, in addition to the lists of manufacturers, add materially to the utility of the book.

The Use of the Slide Rule, by F. A. Halsey. Published by D. Van Nostrand Co., 23 Murray and 27 Warren streets, N. Y. New edition. Price 50 cents.

This is one of the books of the Van Nostrand science series and is in pocket form. It has 84 pages, besides several folding plates, and we think it is the best American treatment of the slide rule for the ordinary user. Unlike many text books upon the subject, it makes no attempt to show how to work out examples in mechanics, steam engineering, etc., but rather it is confined to a discussion of general principles and an explanation of the slide rule by the aid of excellent diagrams. The principles are explained by the aid of problems worked out.

Mathematics. Published by the Doubleday & McClure Co., N. Y. 340 pages illustrated.

This book is one of the home study circle series that this company are now publishing. It contains five chapters upon mechanics bids and estimates, mensuration for beginners, easy lessons in geometrical drawing, elementary algebra, and a first course in geometry. The book is adapted to home study and the matter that it contains was originally published in the "Chicago Record," so there has been every opportunity for its correction and revision. It is probable that any mechanic who wishes to investigate the elementary principles of mathematics and learn how to work out everyday examples will find the book of value. It has the further advantage that several branches of mathematics are treated in one book, of which the price is low.

The National Railroad Master Blacksmiths' Association has recently published a 216-page book of the proceedings at their seventh annual convention. This book contains information which will prove interesting to those engaged in mechanical pursuits. A few extra copies of this book have been printed and can be obtained for 50 cents from the secretary of the organization, Mr. A. L. Woodworth, Lima, Ohio.

## ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9X12, 6X9 AND 3½X6 INCHES.
THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY
TO BE PRESERVED.

Howard Iron Works, Buffalo, N. Y. Illustrated catalogue of pulleys, hangers, shaftings, vises, bolt cutters, etc.

A complete line of appliances for power transmission is given with several styles of vises, grindstone frames, bolt-cutters, belt tighteners, etc. There are several useful tables at the end of the catalogue.

E. G. Smith, Columbia, Pa., has sent us a new catalogue of the Columbia measuring instruments which contains a list of tools on which he is making special discounts for a short time.

The New Process Raw Hide Co. have issued a little flyer giving a few pointers about their noiseless pinions.

The Massey Vise Co., 30 and 32 South Canal street, Chicago, have mailed us a catalogue of their various styles of vises, which, besides the ordinary type, includes a quick-acting vise, a combination pipe vise and a quick-acting grip vise for wood workers. A novel milling machine and planer-vise made by this company has jaws which depress and seat the work as it is clamped.

## MANUFACTURERS' NOTES.

The Newton Machine Tool Works, of Twenty-fourth and Vine streets, Philadelphia, are erecting a new building at Nicetown, for facilitating the filling of their many orders.

The Pratt Chuck Co., of Frankfort, N. Y., are making additions to their plant in order to meet the increasing demands for their product. Among their foreign orders is one from a large railroad company in Great Britain who desire to secure a chuck that will not permit the drill to slip under any conditions and they report a large increase in their domestic orders.

A new company has been organized for the manufacture of a complete line of air compressing machinery under the name of the New York Air Compressor Co. The foundry and machine shop plant of this company are located on the line of the New York and Greenwood Lake Railroad, Arlington, N. J., and the New York offices are at 120 Liberty street.

The Norwalk Iron Works, South Norwalk, Conn., have nearly completed a large addition to their present plant which measures 240x130 feet. The new structure will contain all the modern, up-to-date features and be a model machine shop in every respect.

The Cling-Surface Mfg. Co., of Buffalo, N. Y., report rapidly advancing sales of Cling-Surface, both domestic and large shipments to Mexico and England. Of their many customers the Jeffrey Mfg. Co., of Columbus, Ohio, say: "It is the best material for belts we have ever used." The Standard Hosiery Co., of Philadelphia, report "A gain of 25 per cent. in power, belt very slack and no slipping." Whitehall Electric Light Plant, Whitehall, Mich., say: "Arc light belt 14 ft. between centers, running 4,480 ft. per minute, no slip and 16 inch sag in belt." The General Electric Co. Lamp Works, Harrison, N. J., say: "Have given Cling-Surface a thorough test and it is very satisfactory."

E. G. Smith, manufacturer of fine mechanical tools, Columbia, Pa., announces that there is an increasing demand for his "Which Way" pocket levels, a great many of which are going to foreign countries. He will be pleased to send a descriptive circular to any one interested.

The Tanite Co., Stroudsburg, Pa., still continue to receive large orders for their machines. Among the orders filled is one from the Netherlands Government for a letter "D" machine. They have also received an order from Russia for their surfacing machines and one from an American firm for their two-wheeled No. 5 Grinders. They have also in hand at the present time an order for emery wheels for Russia and New Zealand.

Ottmar Mergenthaler & Co. announced recently that after November 1 their business would be continued on the same lines as heretofore by the Ottmar Mergenthaler Co., a company incorporated under the laws of the State of Delaware.

The Boston Gear Works, Boston, Mass., announce that on or before December 1, they will occupy their new premises, corner of Purchase and Pearl streets, where they will have greater facilities for executing first class work and attending to orders more promptly than heretofore.

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## AT THE UNIVERSITY OF ILLINOIS.

Prof. Wm. S. Aldrich, who was appointed head of the department of Electrical Engineering at the University of Illinois, Urbana, Ill., a few months ago, has sent us a prospectus of the courses in engineering which show the changes that have been made in the electrical department. Five years are now required for the degree of electrical engineer, as it is believed that the title has too great a significance to be earned by a four years' study. A wide range of electives is allowed the students and strong courses are being built up in alternating current working, polyphase subjects, metallurgical testing, and practical laboratory work. Prof. Aldrich was one of the engineers in charge of the repair ship Vulcan during the Spanish war and he has evidently entered into his new work with the same energy and good judgment that he displayed in the difficult management of the details connected with the floating machine shop.

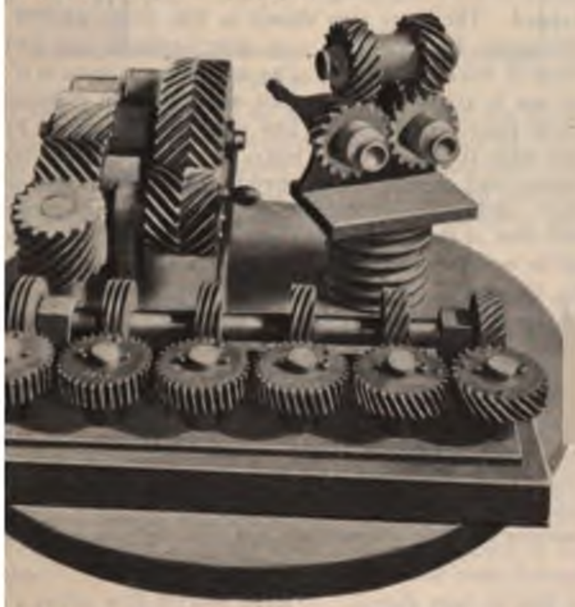
MACHINERY.

6. January, 1900. No. 5.

# AMONG THE SHOPS.

## INTERESTING NOTES TAKEN IN THE SHOPS OF THE ARTHUR COMPANY, NEW YORK

; the numerous general machine shops of New York of the Arthur Company, on Front street, is well worthy on account of the many unique specimens of model ›e seen there, besides shop tools and appliances of more nary interest. The business was started in a modest way g over twenty years ago by James Arthur, the president esent company, which is a close corporation consisting her, two sons and one daughter.



*Models made for technical schools to illustrate the peculiarities gearing. The model in the foreground shows the grada- a worm to a helical gear.*

isiness of the company was originally general repair they are now quite extensively engaged in manufactur- :s for all sorts of service, flanges, hoists, propeller ıt gears, etc. The latter line of manufacture has been only recently, but some as interesting specimens of ng are exhibited as the writer ever saw. Some of this ıown in the clock illustration in Fig. 3. The teeth in all are cut and the train includes specimens of helical and rs, besides the ordinary spur gearing, which, of course, s the greater part of the mechanism.

### An Interesting Clock.

gh the readers of MACHINERY may not be particularly in horology, we think they will be interested in some ails of this clock on account of its design and the me- ıccuracy of the workmanship. Clocks with cut gears re, neither are those which keep accurate time; but this ins features that distinguish it from all others. In the :, all the gears are high numbers, as compared with wheels. Where an ordinary gear would contain six orresponding gear in this clock contains possibly six- ain, as may be noticed, there are two weights, both for ıe pendulum, as there is no striking mechanism. In gement a balancing effect on the first pinion of the train d, as the first pinion is located between the two driving hich turn with the winding drums, and thus it practi- s without pressure on the bearings. The object of this ent is two-fold—first, to secure a constant turning vhile the clock is being wound, and secondly, to reduce nal effect. Of course, while the clock is being wound g effect is only one-half of the ordinary amount; but ctically sufficient to prevent any slowing down for the brief period required for the winding. The escapement is the ordinary dead-beat form, and a simple pendulum is used which approximates a compound pendulum in maintaining a constant length as it is made from a piece of California redwood. The co-efficient of expansion for this and some other woods is so minute that it is doubtful if it has ever been measured. The clock will indicate time from four places, as it has four dials, one below and three above, but, as at present arranged, all the faces indicate the same time. The motion is conveyed to the hands on the upper dials through a vertical shaft driven by helical gears, and the motion is transmitted from the vertical shaft to the hands by accurately cut bevel gears. It is easy to designate gears as being accurately cut, but often a test will show surprising inaccuracies in those which are supposed to be a superior product. In this case, however, any one could perceive a minute error, as it would be greatly magnified by the ratio of the gearing; but a close inspection by the unaided eye fails to detect any perceptible variation in the positions of the four sets of hands on their respective dials. The hands are made of aluminum, and the dials are graduated by an indexing machine; but, although each beat of the pendulum is easily perceived in the movement of each of the four minute hands, the constant register of all the hands is practically the same. Altogether this clock is an interesting specimen of clock-making done, not by a clockmaker, but by a mechanic, and it runs and keeps accurate time, not by reason of looseness of construction and makeshift expedients, but rather because of general mechanical excellence. The human skull to be seen on top of the case is an appropriate, though scarcely cheerful, reminder of the value of time and the inevitable fate awaiting us all.

### Some Helical Gear Models.

The three models shown in Fig. 1 are specimens of the work the company is prepared to do, and the writer was informed that they also make models like those shown, or others, to order for technical schools, etc. The model appearing in the foreground is an interesting thing, as it shows beyond dispute that there is no dividing line between a worm and a toothed gear, but that one graduates imperceptibly into the other. The wheel on the left is what is usually designated as a worm, and has one tooth, or is a single-thread screw. The gear or worm wheel with which it is engaged has 32 teeth, so that 32 turns of the handle are re-

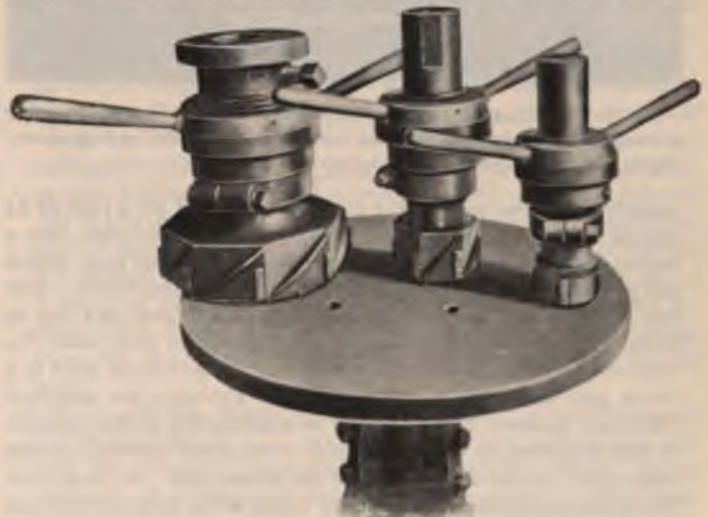


*Fig. 2. Collapsible taps used in the shops of the Arthur Company, for tapping flanges, valves and similar work. The largest one shown measures 8 inches in diameter and has eight thread cutters.*

quired to turn it around once. The next worm to the right has 2 teeth, which are therefore of double the pitch of the first, so that only 16 turns of the handle are required to turn the engaged gear one turn. The next worm has 4 teeth of double the pitch of the preceding worm, and as the engaged gear has the same number of teeth as in the previous instances, only 8 turns of the handle are required for one rotation. The next wheel has 8 teeth; consequently only four turns of the crank are required for a turn of its mating gear. The next wheel, which looks suspiciously like a helical gear, has 15 teeth, and thus drives the engaged gear, which has 30 teeth, one full rotation with two turns of the handle. The last wheel in the row is undoubtedly a helical gear and has 24 teeth, with 24 teeth on the mating gear, giving an even ratio. In view of this model it is rather difficult to say positively what is a worm gear and what is a helical gear. Probably the principal difference between the two forms of gearing lies in the capacity of helical gearing to transmit motion from either member, so that either may be the driver gear or the driven one. A worm and worm-wheel mechanism as usually constructed, however, cannot perform this function on account of the excessive frictional effect, which prevents overrunning, a feature that is often its chief advantage.

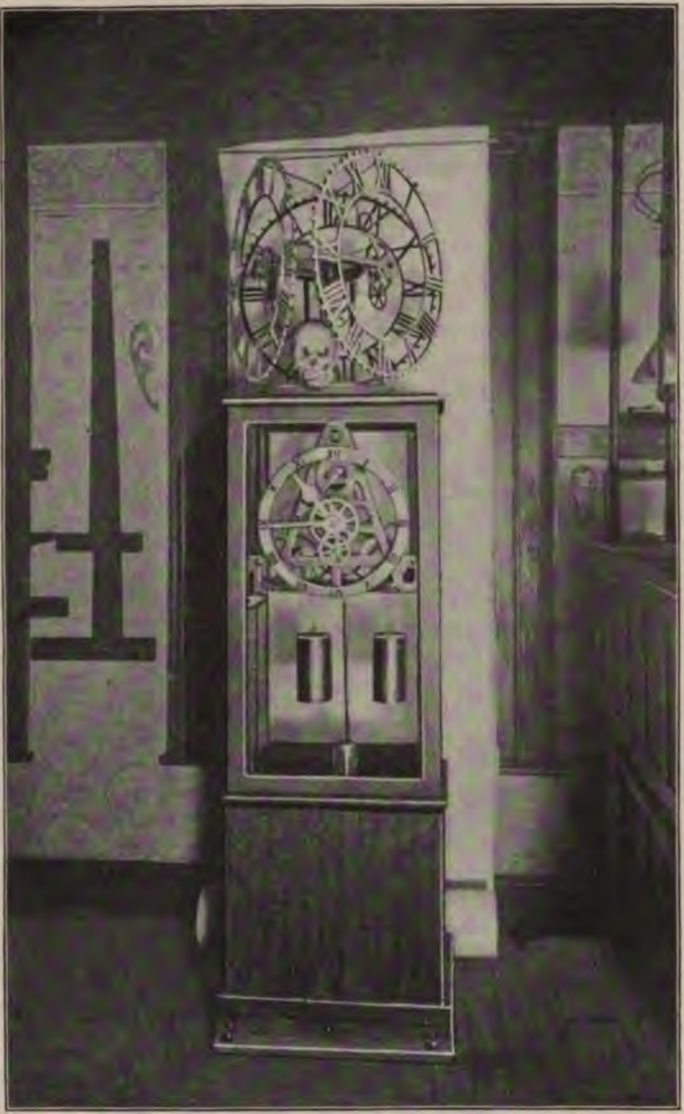


*Fig. 3. The clock shown is an interesting example of accurately cut gearing, and contains, besides, some interesting mechanical arrangements. Eight feet high; upper faces 25 inches diameter.*

Of the other two models shown in the group, little can be explained that is not shown by the photograph. This, however, does not do justice to the subject, as they must be seen in actual operation to appreciate the nicety of construction and the general novelty of appearance. The one at the right consists of four 45° helical gears, two of which are mounted on the same shaft. The lower two are, of course, right and left helices, as are the upper ones which engage with them. The different gears are interchangeable, so that various combinations can be effected. The model at the left is a combination of seven helical gears, the two horizontal shafts carrying three each, and one being shown in the foreground with its axis vertical. This gear can be removed and slipped on the horizontal shaft shown at the back of the frame, thus giving a combination of three helical gears with horizontal axes meshing together. It is obvious that a few models constructed on these lines give students in technical schools more practical information on the operation and possible combination of this style of gearing than will usually be readily learned from text-books. Practical models of this description also leave a more lasting impression, as the mind has a tangible subject to grasp. Many students have great difficulty in understanding the principles of helical gearing, as the difficulty of presenting the third dimension on paper makes the subject somewhat abstruse.

### A Collapsible Tap.

In the manufacture of valves and flanges in large quantities, the usefulness of a collapsible tap is manifest on account of the ease with which sizes may be maintained or varied, and also the time saved in not being obliged to back the tap out of the hole being tapped. The three taps shown in Fig. 2 are part of the shop equipment for this work, and were designed and made for the class of work referred to. The largest one shown is 8", the next in size is 3½" and the smallest one is 2½" in diameter. All of them have thread cutters, like that shown at D in Fig. 4. In the main sketch, A is the body, or shank, which is threaded, as shown, and on which is screwed the collar B, bearing the handles H H. Below B is another collar, which can be gripped solidly on the stem of the tool by the clamping screw shown. The collar B in its movement up or down carries with it a cone-shaped piece, G, the end of which shows in the lower end view. This piece has as many slots as there are cutters, which is usually six or eight. The movement of G gives a positive movement to the cutters, the downward travel forcing them out and the reverse withdrawing them from the tapped thread. The collar C, is a stop to regulate the size of the thread tapped; the lower it is set the larger the thread, and vice versa. Minute differences can be made by a slight turn of C, and the wear of the cutters is easily compensated. If a workman desires to tap one hole somewhat smaller than the general run, and does not care to adjust the collar C, all that he need do is to insert a few thicknesses of paper or other material between B and C, which prevents the cutters from moving to their extreme outward position. Although this tap is quite simple and contains no parts liable to be easily injured, its success undoubtedly hinges on the shape of the inner end of the cutters. As shown at D in Fig. 4, the end, N, makes an angle with the sides that approximates the angle of repose, so

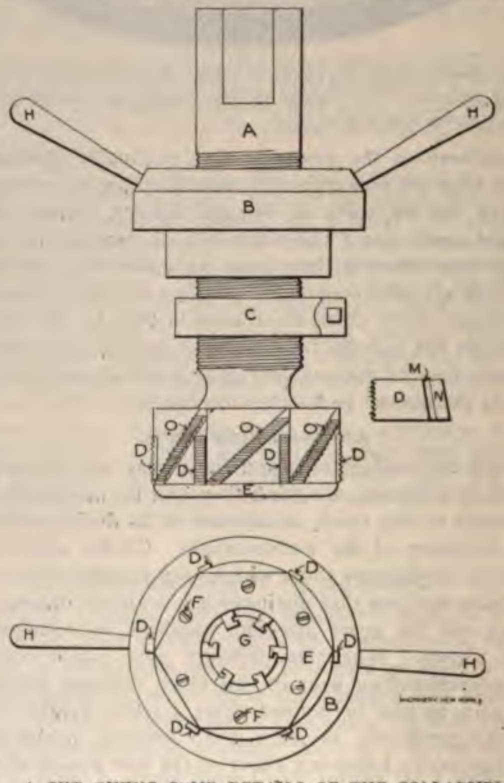


FIG. 4. A CUT GIVING SOME DETAILS OF THE COLLAPSIBLE TAP.

that, while the slotted cone G carries the thrust of all the cutters, the resistance to movement is slight, and no trouble ensues when attempting to back the cutters from the tapped hole. If the angle of the sides of G be greater or lesser than the stated angularity, there is a wedging effect that often requires the extreme efforts of the workman to disengage the tap. Another important feature is the diagonal lands O O O which extend to the nominal diameter of the tap and are therefore threaded but, being of soft steel, of course do no cutting. They are oil distributors and fulfill the function very neatly, distributing the oil *behind* the cutter, instead of in front of it, to be immediately swept away. By the time the advancing cutter has reached the lubricant, it is well distributed over the surface and therefore gives the maximum lubricating effect.

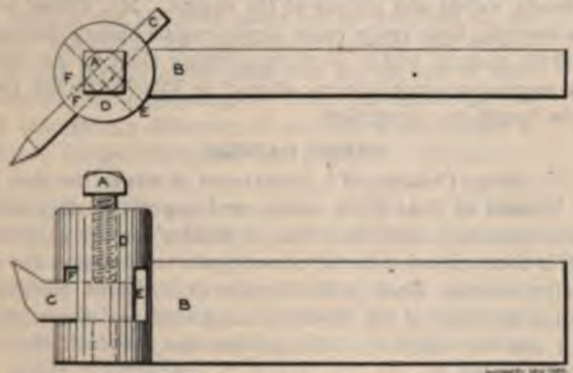


FIG. 5. TOOL HOLDER.

### Lathe Tools.

The lathes in the shop are provided with a neat form of toolholder, which is shown in Fig. 5 and which will be seen to possess considerable merit. The holder consists of the shank B, and the bulb D, which is slotted for two positions of the tool, one being at right angles to the other. A tool may be in position for facing, and it may be removed for a boring tool, which is placed in the other slot. The change can be made without disturbing the position of the holder in the tool-post, which is considered of considerable practical value. Square center reamers are used for centering work, the form used being shown in Fig. 6. The shank of the tool is of soft steel, with a hole clear through, and has a collar with the set screw A. Square steel is used for the center C, which obviously makes a cheap and easily maintained tool. All the lathes are provided with two pairs of centers, one pair having the ordinary 60° angle and the other pair having their points turned to 90°. The latter are used on hurry-up and rough jobs, on which the time is not taken for relieving the centers. As much of the work done in the repair line is of an emergency character for steamships, tugs, etc., anything that will save a few minutes of time on a job is well worth considering.

### Interchangeable Chucks and Face-plates.

All the lathes, drill-presses and milling-machine fixtures take the same sized centers in the respective classes, so that drills, reamers and centers are interchangeable. The lathes in the 13", 16", 20" and 30" classes interchange chucks, so that any 16" lathe can take any of the chucks in the shop that are threaded for that sized lathe. Although this system often requires that new lathes be made to order, or that they be provided with a special spindle, the benefits resulting from it are of much value. The number of chucks required for the shop equipment by this system is not large, yet each lathe can use a large variety of chucks without interference with the other machines, as duplicates are, of course, provided in those sizes which are most used. Mr. Arthur is a strong advocate of the interchangeable system and would extend it to the manufacture of general machine parts by various makers, so that, as in this case, chucks, face-plates and other nose tools could be used on any maker's tools in the various classes.

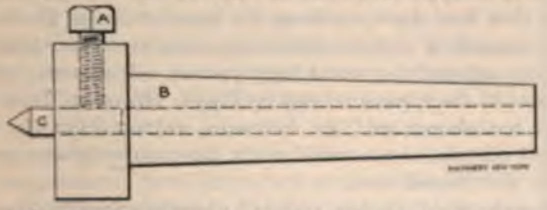


FIG. 6. SQUARE LATHE CENTER WITH REMOVABLE CUTTER.

## THE NEW PRESIDENT OF THE A. S. M. E.

CHARLES HILL MORGAN.

Charles Hill Morgan was born in 1831 of New England parents. His early education was acquired in the Massachusetts' district school, which he attended until he was twelve years old when he was obliged to work in a factory. Some years later he took a course in mechanical drawing, working at night, as he was busy in the shop during the day. These few lessons, however, proved of great value to him in after life. In 1852 Mr. Morgan was put in charge of the Clinton Mills Dye House. Later, from 1855 to 1860, he was mechanical draughtsman for Erastus B. Bigelow, inventor and manufacturer. In that capacity, he introduced a system of designing and constructing cam curves for looms.

In 1864 he became superintendent of manufacturing for the firm of Washburn & Moen, Worcester, Mass., and four years later was made general superintendent. He then made seven different trips to Europe and visited the mills of England, France, Germany, Belgium and Sweden, acquiring a vast amount of valuable information and many ideas which were of great benefit to the firm. One of the inprovements in the wire business with which Mr. Morgan was connected was the development of the continuous rolling-mill originally built by George Bedson, Manchester, England. His first important improvement on this mill was a power reel; the second, the introduction of a continuous train of horizontal rolls. The original rolling-mill had horizontal and vertical axes alternately. The improved mill, consisting of a series of horizontal rolls with intermediate twist guides between them, giving the metal one-quarter of a turn in its passage from one pair of rolls to the next, was far superior to the old one.

Since 1887 Mr. Morgan has been associated, as president, with the Morgan Spring Co., manufacturers of wire and springs, and with the Morgan Construction Co., Worcester, Mass., manufacturers of rolling-mill and drawing machinery. The latter especially, have been most successful, and their designs and machinery are being adopted by many. They have given special attention to the continuous rolling of billets, merchant bars, rods and hoops, and developed the continuous method of heating billets, and finally introduced the continuous gravity discharge furnace, the invention of Mr. Morgan.

Besides the active part he takes in all that concerns his immediate business affairs, Mr. Morgan is a member of the Board of Trustees of the Worcester Polytechnic Institute, in whose growth and success he is greatly interested. He is also a member of the British Iron and Steel Institute and of the American Institute of Mining Engineers

# TWENTIETH ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The twentieth annual meeting of the American Society of Mechanical Engineers, which was held in New York from December 5 to December 7, was the largest and one of the most successful that the society has had. There were over 700 names registered. On Tuesday evening, December 5, Admiral George W. Melville delivered the president's address upon "Engineering in the United States Navy." On Wednesday morning the usual business was transacted and a few professional papers were read. The report of the council showed that there are now 1,957 members of all grades, and it was announced that among the special business matters to be considered were the erection of a memorial to Robert Fulton in Trinity churchyard, New York, for which $900 have already been subscribed, and the arrangements for the proposed European trip of the society at the time of the Paris exposition. Since this meeting, a notice has been sent to the members of the society giving particulars about this trip. Prof. Unwin of England, the well-known authority on machine design, was elected to honorary membership. A number of duplicate books from the library have been presented to the University of Virginia, which recently sustained a heavy loss from fire. The society has acquired two valuable collections of books owned by former members, and a water-color drawing bearing the signature of Robert Fulton and showing an aqueduct scheme for carrying a canal across a river has also been presented to the society.

Of the various committees appointed the one that has been at work so long upon the code for boiler trials presented its completed and revised reports. The one appointed last May to consider the matter of standard dimensions for direct connected generators and steam engines will probably present a report at the next meeting, and the committee upon steam-engine trials will also be prepared to report at a later meeting.

The president elected for the coming year is Mr. Charles H. Morgan, of the Morgan Construction Co., Worcester, Mass., a sketch of whose life appears elsewhere. It is probable that the next meeting will be held in Cincinnati, in May.

### THE STEAM ENGINE AT THE END OF THE NINETEENTH CENTURY.

At the conclusion of the business Prof. Robert H. Thurston presented the first professional paper of the session upon the progress of steam-engine economy during the past century, with special reference to a recent test upon a quadruple expansion pumping engine built by the Nordberg Mfg. Co. This engine holds the world's record for pumping engines, having a duty of 162,984,824 foot-pounds per 1,000,000 B. T. U., as against 150,100,000 foot-pounds realized by an engine built by the Snow Steam Pump Works, which previously stood a little higher in the scale than any other engine. It gave this duty, too, with a consumption of 12.26 pounds of steam per horse power per hour, whereas the Snow engine used only 11.26 pounds. This seeming paradox is due to the peculiar arrangement of the engine, whereby a quantity of steam from the jackets and receivers is led to a series of feed-water heaters, with the result that the feed-water is brought to nearly or quite the temperature of the steam in the boiler, before it enters the boiler. Thus, while this engine nominally consumes more steam than several others, the loss is more than balanced by the heat that is returned to the boiler in the feed-water, and the net result is a gain in thermal efficiency.

This paper is extremely valuable, but it is too elaborate to permit even an abstract to be given here. In the Nordberg engine the attempt is made to operate upon the so-called "regenerative cycle," proposed by Prof. Cottrell, and the theoretical side of the subject is treated fully by Prof. Thurston. He also gives elaborate tables of engine performances, and among other diagrams, one showing the steady improvement in economy and the reduction of internal wastes of the best engines from 1750 to 1900.

In the discussion Charles T. Porter requested that the record of engine performances for this century be not closed until the end of the coming year, the last year of the century. He said that he expected to produce an engine that would operate on 9 pounds of steam per horse-power per hour, and in response to an enquiry as to how this was to be accomplished, said, mainly by the use of high pressures and by jacketing the cylinder barrels, heads, valves and pistons of the engine. Mr. Porter is one of the few who have really made steam-engine history during the nineteenth century, and it would be a fitting close of the century and a merited accomplishment should he succeed in the results that he hopes to accomplish.

### OTHER PAPERS.

C. V. Kerr, Chicago, Ill., next read a paper on the Berthier Method of Coal Calorimetry, and urged that this method be more generally used than that of Mahler's bomb calorimeter which is recommended in the committee's report upon the code for boiler testing. Prof. J. E. Kinealy, of St. Louis, contributed a written criticism of the Berthier calorimeter, in which he held that it was not adapted to the general use to which Mr. Kerr proposed to put it.

John A. Laird, St. Louis, Mo., reviewed tests made upon two 10,000,000 gallon pumping engines constructed by the E. P. Allis Co. for the St. Louis Water Works. The engines are three cylinder triple expansion, condensing, vertical, with rigid connections between plungers and pistons and three single-acting plungers. The diameters of cylinders are respectively, 30 inches, 54 inches and 80 inches. The plungers are 25½ inches in diameter, and all are 64 inches stroke. There are two receivers, the heating coils inside of which are helical and extend for the full length of the receivers. The cylinders are jacketed on the sides, but not on the heads. The results of the tests contain the following items:

| | | |
|---|---|---|
| Feed-water per I. H. P. per hour, lbs. | 11.648 | 11.653 |
| Dry steam per I. H. P. per hour, lbs. | 11.627 | 11.632 |
| Duty per million British thermal units, ft. lbs. | 143,404,000. | 144,365,000. |

A calculation of the pressure in a pipe due to the stoppage of a flowing liquid was presented in a brief paper by George M. Peek, New York City. His method is to first find the increase due to sudden stoppage, taking into account the comprehensibility of the liquid and the elasticity of the pipe by equations which he deduces, and then add to this the static pressure due to the head, and also a pressure due to twice the velocity head and the friction head.

There was also at this session a paper by H. T. Eddy, containing a new graphic method of constructing a temperature-entropy diagram.

* * *

## THE THIRD SESSION.

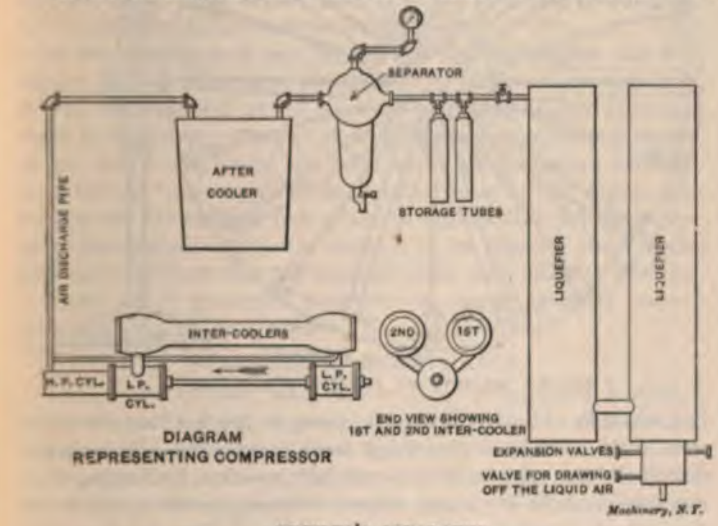
### COMPRESSION AND LIQUEFACTION OF GASES.

The paper by Arthur L. Rice, Brooklyn, N. Y., upon the compression and liquefaction of gases, was the first one read at this session. It gives an historical and descriptive account of the efforts that have been made at the liquefaction of the various gases, concluding with an interesting account of the means that have been adopted for producing liquid air. Diagrams, with descriptions of the apparatus used by Linde, Hampson, Dewar and Tripler are shown, and the following extract from the paper gives an account of the work of the latter investigator, in connection with liquid air:

Although liquid air has received considerable attention from different investigators, Tripler, Linde and Hampson should be mentioned as having been aiming at the simplification and cheapening of the production, so that the liquid may be made of use. All three have been working along the lines of a direct regenerative action, as suggested by Siemens. Dewar has also done work along this line, combined with cooling by a separate fluid, but in a smaller way as would be expected in a chemical laboratory. The principle is this: a perfect gas expanding to do work loses heat; if this cooled gas be exhausted so as to jacket the pipe through which the incoming gas enters, it will cool that incoming gas; the process is cumulative without limit, if the machinery is frictionless and insulated against heat from the surrounding objects. Solvay built a machine on this principle, but was unable to get lower than — 139 degrees Fahr. (95 degrees C.), on account of the heat due to the friction of the pistons and to conduction.

In a perfect gas, no lowering of the temperature would result from lowering of the pressure by free expansion, but none of the so-called gases are perfect, and all are cooled somewhat by expansion through an orifice. Joule and Kelvin found that with air the fall of temperature is about 6.45 degrees Fahr. (¼ degree C.) for each atmosphere difference of pressure at the orifice, at ordinary temperatures, and that the effect increases as the temperature falls, because the gases are coming more nearly to the vaporous state. If then, air be compressed to a high pressure and be allowed to expand through a small orifice, it will become considerably cooled and may be used to cool the incoming air which, in turn, will lose heat by expansion; the process may be carried on until some of the air, on or before leaving the orifice is liquefied.

Tripler's English patents of 1891 seem to be the first specification of any definite machinery for thus liquefying air.



TRIPLER'S APPARATUS.

Mr. Tripler's apparatus, shown in the accompanying sketch, consists of a three-stage compressor drawing air directly from the atmosphere and driven by a steam engine. The air is taken first into the low-pressure cylinder, where it is compressed to 65 pounds per square inch. It is then sent through an intercooler to reduce the temperature to that of the atmosphere, and taken into the intermediate pressure cylinder. From that, at a pressure of 400 pounds, it is taken through a second intercooler to the high-pressure cylinder, where it is forced up to 2,000 to 2,500 pounds and thence sent to the aftercooler to be reduced again to the temperature of the atmosphere. The air is passed through a separator to take out all moisture and then passes to storage tubes in which compressed air, not in the liquid form, may be kept. The liquefier is Mr. Tripler's special invention. It takes the air from the separator and, by expansion through a coil of pipe and a small orifice, cools it to a low temperature, then passes up around the coil of pipe, cooling the air inside and thus giving the regenerative action. The expansion valve is placed at a little distance above the bottom of the coil, so that some liquid air collects in the bottom of the coil, and thus serves to further cool the air as it comes to the expansion cock. The air which is to be drawn off collects in the liquefier just below the expansion valve, and may be drawn off at will. The expanded air escapes to the atmosphere after having been used to cool the coil of the liquefier. The capacity of the present plant is two to four gallons per hour, and the air will begin to liquefy in fifteen minutes after starting up. No data are available as to the power used in the compression.

## BLUE-PRINT FRAME.

In a brief paper Paul Mellen Chamberlain of Chicago, described a novel blue-print frame. He said: The desirable features of a blue-print machine are ease and rapidity of operation, such adjustment as to secure the direct rays of the sun, and means whereby close contact between the tracing and the sensitized paper may be secured. The machine here described and illustrated was designed to meet the above requirements, and was first built for, and in the shops of, the Lewis Institute.

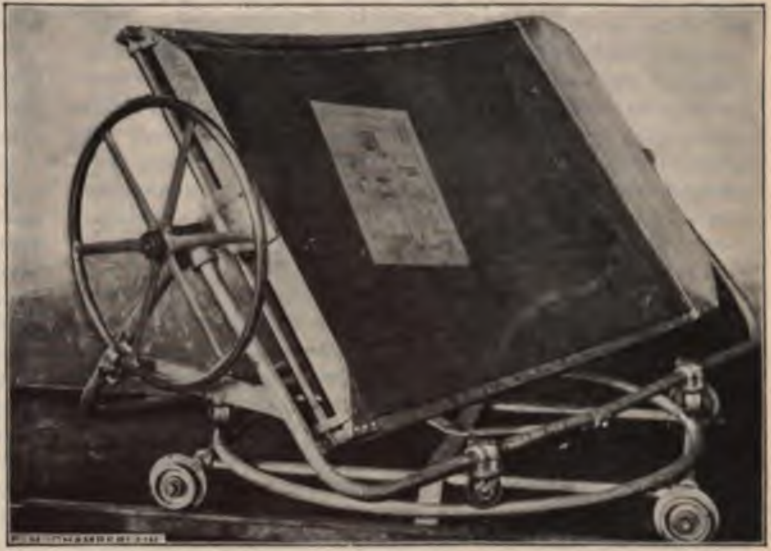


FIG. 1. NOVEL BLUE-PRINT FRAME.

The operation of the car and the universal adjustment is so clearly shown in Fig. 1 that explanation seems unnecessary. The iron work is all galvanized to avoid rusting after exposure to rain or snow. The glass is curved to a radius of thirteen feet. Attached to one end of the frame is a sheet of canvas-rubber packing about one-thirty-second of an inch thick. The other end of the rubber cloth is fastened to a steel tube which serves as a roller to roll cloth on and also as a stretcher.

The operation is this: The rubber cloth is rolled back on the steel tube, and the paper and tracings are placed on the convex side of the glass; the cloth is unrolled with one hand, leaving the other free to adjust or turn down crumpled edges of the tracing, as shown in Fig. 2, the ends of the steel roller are engaged by hooks operated by cams at the end of the frame, and a turn of the handle stretches the cloth, giving a pressure component normal to the glass; the frame is turned over, the car pushed out of the window, and the frame adjusted to the proper angle with the sun's rays. The operation is rapid, the placing of tracings very easy, and the contact obtained between tracing and paper all that could be desired.

Another paper by Mr. Chamberlain described an apparatus consisting of a lathe swung like a cradle dynamometer and having an autographic apparatus consisting of a pencil attached to the lathe carriage, which marks on a concave card concentric with the swing of the machine. The power absorbed by the

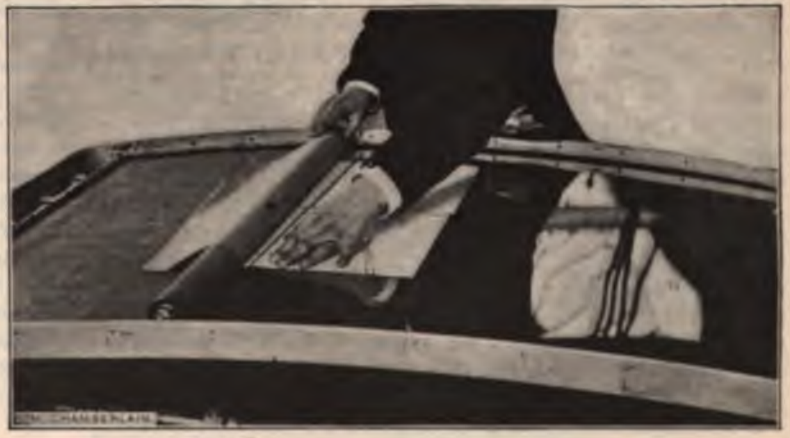


FIG. 2. METHOD OF OPERATING.

tool in cutting is thus accurately indicated by the tracing made by the pencil. The experiments made up to the present time show that the pressure on the tool is independent of the cutting speed and the metal removed is proportional to the pressure.

The education of machinists, foremen and mechanical engineers formed the subject of a paper by M. P. Higgins of Worcester, Mass., which closed the evening's proceedings and again introduced the much-debated question of technical education. The paper attracted marked attention and was discussed at length by many members. The paper and discussions cover too much ground to be summarized here, and further reference to them will be deferred until a future issue. It is expected that more discussion of the topic of techinal education will be introduced at the next meeting of the society.

* * *

## FOURTH SESSION.

On Thursday morning the first paper was by Herman Poole of New York, upon using gasoline gas for boiler heating. The boiler used was of tubular pattern, with heating surface and grate area in the ratio of 26 to 1, and 1,211 pounds of water were evaporated from and at 212 degrees by 35 gallons of gasoline. This is at the rate of 34.7 pounds of water per gallon of oil, or about one boiler horse-power was generated per gallon. Compared with the gasoline engine, which uses only a fraction of this quantity of oil per horse-power, the results make rather a poor showing.

### PACKING TESTS.

The next paper was upon the subject of the friction of steam packings, by Prof. C. H. Benjamin, of Cleveland. It outlined tests that have been made at the Case School of Applied Science with a special apparatus designed for this purpose. The apparatus consists of a cast-iron cylinder, 6x13 inches inside, fitted at each end with a cover and stuffing box suitable for a two-inch rod. The rod was given a reciprocating motion by means of a slotted cross-head and crank; a pulley on the crank was connected by a belt with the pulley of a transmitting dynamometer; steam was admitted to the cylinder by a pipe, and the water of condensation was drained off from time to time at the bottom.

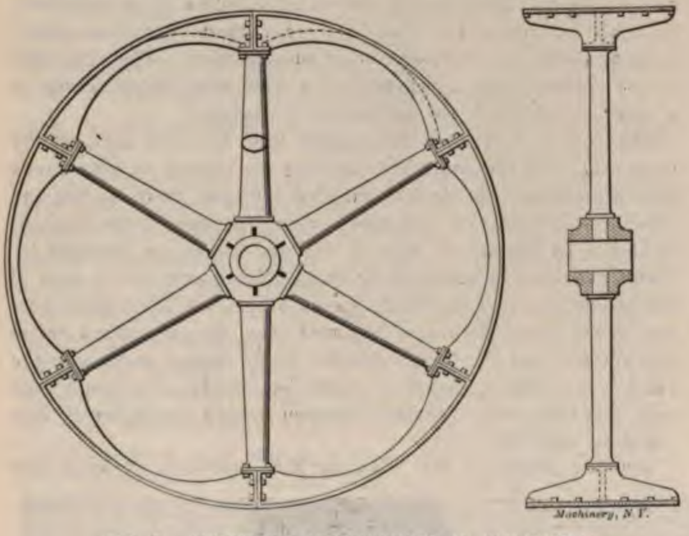


FIG 1. SUGGESTED IMPROVEMENT IN FLY-WHEELS.

A steam gauge attached to the cylinder showed the internal pressure at any instant. The adjusting nuts of the gland were usually tightened only by the fingers, but where a wrench was used it was turned by a spring balance and the turning moment noted. The travel of the rod was 4.25 inches and the usual speed about 200 revolutions per minute, giving a piston speed of about 140 feet per minute.

The conclusions drawn from the test are that

1. The softer rubber and graphite packings, which are self-adjusting and self-lubricating, consume less power than the harder varieties. Old braided flax style, gave very good results.

2. Oiling the rod will reduce the friction with any packing.

3. There is almost no limit to the loss caused by the injudicious use of the monkey-wrench.

4. The power loss varies almost directly with the steam pressure in the harder varieties, while it is approximately constant with the softer kinds.

It was objected by some who joined in the discussion that the methods of making these tests did not conform nearly enough to actual practice, and the suggestion was made that the most satisfactory determination of the friction of a packing was by measuring the wear of the rod in a given time.

Following this paper came a report of tests of a locomotive slide valve, by Frank C. Wagner, Terre Haute, Ind., showing that from 1½ to 3 1-3 horse-power were required to operate the valve.

### THE SUBJECT OF FLY-WHEELS.

A Note on Flywheel Design, by A. J. Frith, New York City, was a comment on the peculiar action of a flywheel, described before a previous meeting of the society. The wheel had speeded beyond the safe limit and cracked in several places where the arms joined the rim, although it did not go to pieces. Mr. Frith contended that this action was due to the arms and rim not being proportioned so that both would have the same unit stress when running, and that if a wheel were so proportioned, it would be much safer, because all of its parts could extend to the same scale, so to speak. This condition cannot be brought about in a wheel as ordinarily designed, owing to the fact that the tension in the arms from centrifugal force must necessarily be less than in the rim. It can be accomplished, however, by making the rim thicker at the arms than midway between the arms, and it is the author's suggestion that the ribs of the rim be curved gradually from arm to arm on the sides next the hub, as shown in Fig. 1, this curve being made to conform to the natural catenary curve, which the particles would take if left free to arrange themselves as the forces induced. The part of the curve next the arms should make an angle of 60 degrees with the center line of the arms.

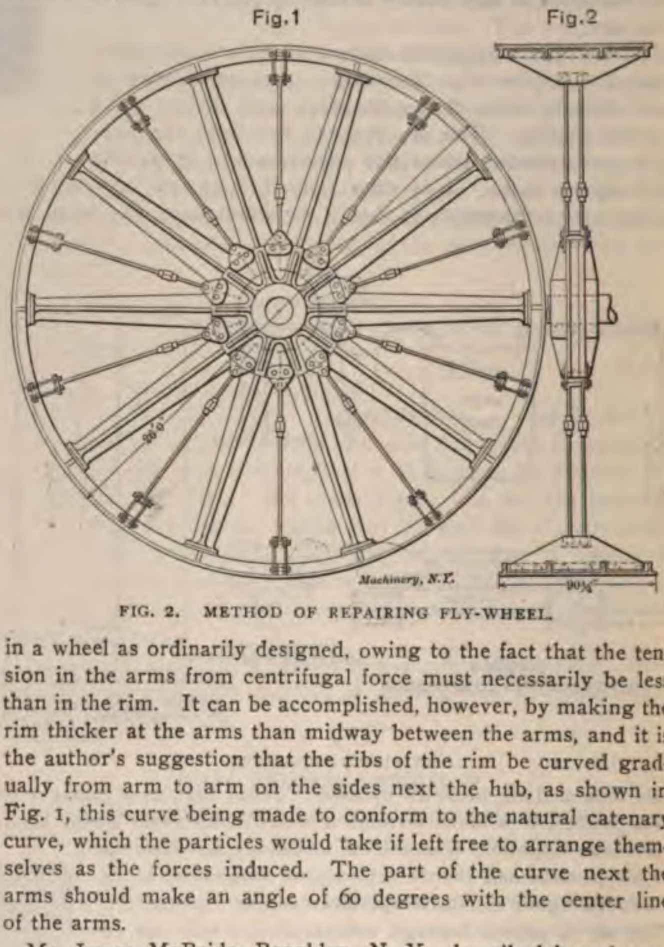


FIG. 2. METHOD OF REPAIRING FLY-WHEEL.

Mr. James McBride, Brooklyn, N. Y., described how he repaired a large flywheel and brought out in a very practical way the point that was made in the previous paper by Mr. Frith with regard to the danger arising from the bending of the rim between the arms of the pulley. The flywheel in question was a large Corliss wheel, weighing between thirty and forty tons, carrying two belts, one 48 inches wide and another 34 inches wide. The broad rim for these belts was supported by only one set of arms which were bolted between two central discs serving the purpose of hubs at the center and bolted to the rim midway between the rim joints at their outer ends. The engine ran away, owing to defective action of the governor, and several cracks appeared in the rim near where the arms were joined and which were clearly due to the bending of the rim, as above mentioned. The wheel was repaired between the times when the engine was shut down, amounting to only four hours a day, and when finished was undoubtedly stronger than originally. The method of repair is shown in Fig. 2, and was to attach plates to the flanges of the rim where the segments were bolted together and also to the hubs midway between where the arms joined them. These plates were then connected by tie bolts or tension rods that were strong enough to take the strain of the centrifugal force of the parts of the rim between the arms. The construction of the wheel was such that these changes could be made without drilling new holes, and the details were worked out in an ingenious manner at a cost of less than $500.

### GAS ENGINE TEST.

A report of an efficiency test of a 125 horse-power gas engine formed the subject of a paper by C. H. Robertson, Lafayette, Ind. The test was made in a plant using natural gas costing .07 cents per thousand feet, but so arranged that gasoline vapor can be used if the gas from the main is for any reason shut off. The jacket water is cooled by means of a cooling tower consisting of tiling piled loosely in a large tank, through which the water trickles and is used over again. The exhaust pipe is conducted underground to a cistern under the building open to the air through a tile 10 inches in diameter. The tests were made to determine the power developed, the gas consumed, the speed regulation and such incidentals as the heat given to the jackets and the temperature of the exhaust. The gas measurements were reduced to equivalent quantities of gas at 14.7 pounds pressure and 62 degrees Fahr., as is necessary in order to make fair comparisons with the performance of other engines. The following average results were obtained: Average indicated horse-power, 88.79; brake horse-power, 73.27; gas per indicated horse-power hour, 14.18 cubic feet; gas per brake horse-power hour, 17.96 cubic feet; thermal efficiency of engine, 14.6. The engine ran at 270.8 revolutions per minute, and was in ordinary working condition, no effort having been made to have it in better than average condition. The engine, also, is of old style and probably is not so economical as more modern ones.

In the discussion it was pointed out that the engine was designed chiefly to regulate closely with a variable load, and that it was not operating at full capacity, which conditions were adverse to economy. The test showed that the proportion of waste in the jacket was about the same as in small engines and the fact that the temperature of the exhaust gases of this engine are so hot that the exhaust pipe glows at night called out the story of a gas engine, which was reputed to be running under such adverse conditions that the exhaust gases were made to operate a boiler which generated steam for an engine of more power than the original gas engine!

### STRENGTH OF STEEL BALLS.

The results of tests made at the Rose Polytechnic Institute upon steel balls were reported by J. F. W. Harris. Balls were procured of sizes ranging from ½" to 1" in diameter from six manufacturers and the attempt was at first made to test the balls by crushing between hardened steel plates. Difficulty was experienced, however, in procuring steel so hard that it would not indent under the pressure to which it was subjected in contact with the balls, and the plan was adopted of placing three balls in a row in a special holder, which kept them in line axially. Pressure was then brought to bear upon the two outer balls, eventually crushing the middle one. After this series of tests was completed, a steel was found that answered the purpose for testing the balls between flat surfaces and another line of tests was conducted with the balls between two flat plates of this steel. A singular fact is that in the first series nearly all the balls were broken by the formation within the ball of a conical wedge which was gradually forced toward the center of the ball until the latter was split. The base of the cone was approximately circular, with its center at the point at which the crushing force acted. The following table gives average results of the two series of tests. It will be seen that the values in the last horizontal row are higher than in the second row, showing that the balls withstood more when tested between flat plates than when they had the point contact, simply, of the first test.

BREAKING PRESSURE IN POUNDS.

| Diameters. | Strength. | | | | | |
|---|---|---|---|---|---|---|
| | ⅛ | ¼ | ⅜ | ½ | ⅝ | 1 |
| Between two balls | 2,000 | 4,000 | 8,000 | 15,000 | 22,000 | 60,000 |
| Between flat plates | 2,000 | 5,000 | 12,000 | 20,000 | 32,000 | 90,000 |

In discussing this paper Oberlin Smith suggested that the subject be taken up more extensively and treated not only experimentally, but from a mathematical standpoint, as well. To this Mr. Pratt, of the Sprague Elevator Co., said that he thought very little could be done mathematically because there was a lack of uniformity in the strength of the balls that are now to be had, and until they gave uniform results under test, no theoretical considerations would hold true.

### COLORS OF HEATED STEEL.

Maunsel White and F. W. Taylor gave the results of extended experiments upon colors of heated steel corresponding to different degrees of temperatures, which are briefly summarized in the following quotation from their paper:

The temperatures corresponding to the colors commonly used to express different heats, as published in various text books, hand books, etc., are so widely different as given by different authorities, it is impossible to draw any definite or reliable conclusion. The main trouble seems to have been in the defective apparatus used for determining the higher temperatures. The introduction of the Le Chatelier pyrometer, within the last few years, has placed in the hands of the scientific investigator, an instrument of extreme delicacy and accuracy, which has enabled him to determine temperatures through the whole practical range of influence.

The nomenclature used for color heats differs with different operators, but in our investigation we have adopted that which seems more nearly to represent the actual color corresponding to the heat sought to be represented. We have found that different observers have quite a different eye for color, which leads to quite a range of temperatures covering the same color. Further, we have found that the quality or intensity of light in which color heats are observed—that is, a bright sunny day, or cloudy day, or the time of day, such as morning, afternoon, or evening, with their varying light—influence to a greater or less degree the determination of temperatures by the eye.

After many tests with the Le Chatelier pyrometer, and different skilled observers working in all kinds of intensity of light, we have adopted the following nomenclature of color scale with the corresponding determined values in degrees Fahr. as best suited to the ordinary conditions met with in the majority of smith shops:

| | |
|---|---|
| Dark blood red, black red | 990° |
| Dark red, blood red, low red | 1,050° |
| Dark cherry red | 1,175° |
| Medium cherry red | 1,250° |
| Cherry, full red | 1,375° |
| Light cherry, bright cherry, light red (heat at which scale forms.) | 1,550° |
| Salmon, orange, free scaling heat | 1,650° |
| Light salmon, light orange | 1,725° |
| Yellow | 1,825° |
| Light yellow | 1,975° |
| White | 2,200° |

With the advancing knowledge of, and interest in, the heat treatment of steel, the foregoing notes, it is hoped, may prove of some value to those engaged in the handling of steel at various temperatures, and lead to further and wider discussion of the subject, with a view to the better understanding and more accurate knowledge of the correct temperatures. The importance of knowing with close approximation the temperatures used in the treatment of steel, cannot be over-estimated, as it holds out the surest promise of success in obtaining desired results.

This demand for more accurate temperatures must eventually lead to the use of accurate pyrometric instruments; but at present the only available instruments do not lend themselves readily to ordinary uses, and the eye of the operator must be largely depended upon; therefore, the training of the eye, by observing accurately determined temperatures, will prove of much material assistance in the regulation of temperatures which cannot be otherwise controlled.

* * *

## CLOSING SESSION.

The session on Friday morning was the last, and among the excellent papers that were read the one by Walter C. Kerr, New York City, deserves special mention, although it will not be possible to give an abstract of it. It described and illustrated the mechanical equipment of the New South Station at Boston, Mass., which in many respects is the most remarkable station in the world. This paper had many illustrations and diagrams and over 100 pages of text. It was prepared jointly by the different engineers who were engaged upon the installation, and is a valuable record of a great engineering enterprise. A peculiar feature about this plant is that it was designed and contracted for, complete, by one firm of engineers and manufacturers, Westinghouse, Church, Kerr & Co., and this fact caused considerable discussion as to whether this practice was as desirable as employing engineers not connected with the construction of the apparatus and machinery.

W. J. Keep, Detroit, Mich., opened this session by describing an extensive series of tests upon the effect of impact upon test bars, which also is not susceptible of satisfactory condensation, and those interested should refer to the paper itself.

### GAUGE FOR HIGH PRESSURES.

F. H. Stillman, New York, gave an interesting account of experiments that had been performed at the West Virginia Agricultural Experiment Station with a small press that his firm had built for obtaining high pressures, 450,000 pounds having actually been attained. In connection with this he outlined a method for measuring these enormous pressures with great accuracy, which is at once so simple and so interesting that we quote the following:

"These pressures may be determined by a picnometer bottle which differs from an ordinary glass-stoppered bottle only in that the top of the stopper is expanded into a little bowl or cup which, when the stopper is in position, communicates with the interior of the bottle by means of a very fine capillary hole through the stopper, is weighed accurately, empty, then weighed full of mercury, which, of course, gives the weight of the volume of mercury necessary to fill the bottle. The mercury is then poured out and the bottle filled with the liquid whose compressibility is to be determined, the stopper inserted firmly, and a quantity of mercury poured into the little cup. Although the mercury is much heavier, of course, than the liquid (*e. g.* for example, water) in the bottle, the mercury cannot enter the bottle, because the water and mercury cannot pass each other in the capillary hole. Any difference in pressure, however, will allow either the mercury to flow into the bottle, or the liquid within the bottle to flow out, depending upon whether the pressure is higher without or within the bottle. The little bottle loaded in this way (with mercury in the cup, and the liquid whose compressibility is to be determined in the bottle) is placed under pressure in the usual way, when just enough mercury will enter the bottle (and fall to the bottom) to make up for the compression experienced by the liquid (water) in the bottle under the pressure applied. On removing the pressure a quantity of the liquid (not the mercury) will be forced out through the stopper; but this does not matter, as everything is estimated in terms of the mercury, which is then poured out, dried, and weighed, and from the weight of this quantity of mercury and the weight of the quantity required to fill the bottle the compressibility of the water liquid is estimated.

"By means of these little picnometer bottles the compressibility of any liquid may be determined under any pressure up to that of the crushing strength of steel, and having determined, once for all, the compressibility of mercury and of some other liquid, preferably water, this method can be used to determine with great accuracy the pressure on the liquids in hydraulic machinery, etc.

"It would only be necessary to load one of these little bottles with water and mercury, as described, and place it in a tube communicating with the liquid in the hydraulic machine. In this proposed gauge the accurary depends solely upon the elasticity of the water and mercury and the balance used in the weighings, and liquids are perfectly elastic; and the analytical balance has reached about as high a degree of perfection as any instrument known to science. The accuracy or delicacy of this gauge hinges upon determining volumes by weighing mercury, and there is hardly a determination known to science that can be made with greater accuracy. The quantities of mercury to be weighed would, of course, depend upon the size of the bottle used; but even when working with a bottle two inches long by three-fourths of an inch in diameter, the quantities of mercury are sufficient to enable a reasonably good balance to detect differences in pressure of a pound throughout the range of the several hundred thousand pounds mentioned."

The last paper of the closing session was "On the Value of a Horse-Power" by George I. Rockwood, of Worcester, Mass. The water boards of our cities are acquiring by legislative processes streams now yielding water power for industrial purposes; and it is of the greatest importance, alike for mill owners and water commissioners, to have a rational basis upon which to adjust the losses due to the confiscation of such powers. This paper does not attempt to propose a basis for adjustment, but simply summarizes the difficulties experienced by the city of Worcester during the past year in settling with the owners of developed privileges along the Blackstone River, part of the waters of which the city has taken for the city water supply. The power owners claimed that a horse-power is a piece of property which may be considered to have a definite market value, and that the settlement should be on the basis of this market value. The city, however, claimed that a horse-power could not be considered as a commodity and that what the owners had lost by the diversion of water was simply the right to generate power and that they should be compensated by a sum sufficient to generate this power by other means continuously.

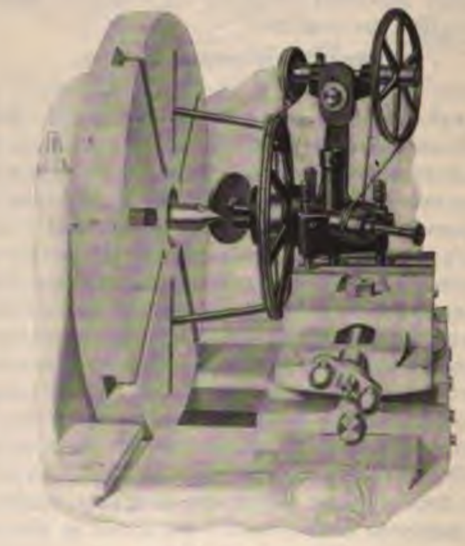
This paper was discussed freely and a motion was finally made and carried, for the appointment of a committee to consider the subject and formulate definite principles that might serve as a guide in future disputes of this nature.

* * *

## SIMPLEX CENTER GRINDER.

The simplex center grinder, shown in the accompanying illustration, is manufactured and patented by Herman Dock, Philadelphia, Pa., and is named from the ease with which it can be adjusted to the lathe, and its simplicity of construction. It has a triangular shaped body, having a hub on which revolves the driving wheel as shown in the illustration. Through the center of this hub, at an angle of thirty degrees, is the bearing of the grinding spindle, which is driven through the intermediate pulleys and the belts, connecting this spindle with the driving wheel.

The driving wheel is connected with the face plate by a steel rod bent in the form of a U and having two arms engaging the face plate and which are thus free to rock in bearings on opposite spokes of the wheel. The center of this steel rod is bent into the form of a half-ring so that it clears the hub of the wheel. This makes a compensating device which gives a constant driving speed regardless of the position of the cross slide with respect to the center of the lathe. The grinder spindle is uncovered, but there is no danger of cutting, for during its forward and backward motion an efficient wiping device keeps out all grit. It is said that it takes only one minute to set the simplex grinder on the average lathe and that the average centers can be ground in about two minutes. It can be used so easily that it enables a shop to secure the advantages of hardened live centers without any trouble in keeping them in proper condition.



LIVE CENTER GRINDER.

## GAS ENGINE DESIGN.—2.

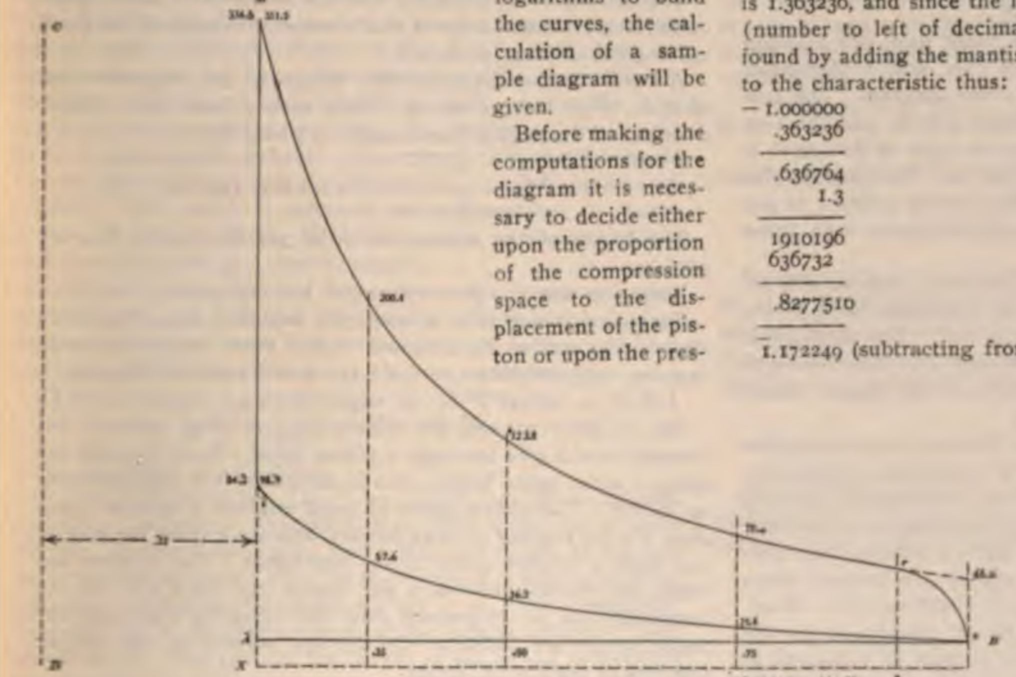
### DIRECTIONS FOR LAYING OUT AN IDEAL DIAGRAM.

E. W. ROBERTS.

The principal dimensions of a gas engine and those upon which a great many of the other dimensions are based, are the diameter of the cylinder and the length of the stroke. While there are several ways in which these dimensions may be determined, the most rational one is from the mean effective pressure and the speed, i. e., the number of revolutions made by the crankshaft in one minute. In order to obtain the M.E.P. with any degree of certainty the indicator diagram should be laid out and the M.E.P. obtained from that. This may seem a difficult task, and to a certain extent it is; but a very close approximation to the actual diagram can be obtained with a little care, and when obtained, this diagram will be found a very good index to the behavior of the gases at the various points of the cycle. The writer will give, in addition to the method of building up this diagram, a general formula applicable to this problem. He believes that the designer who wishes to make a basis of the matter of the behavior of the gases will find much to aid him in the diagram.

In designing a gas engine it is usual to base its dimensions on what its performance will be when using either gasoline or natural gas and to deduce from these figures its output when working with fuels of less heat value. The writer will therefore show how to build up the diagram for an engine using natural gas of average quality. By reference to Fig. 2 (Part I.) it will be seen that the diagram consists of two curves and a straight line. The compression curve is the first part of the diagram to be produced, then the straight line denoting the rise of pressure due to the explosion, then the compression curve and lastly a small curve denoting the fall of pressure after release. This latter curve is of little moment and will be considered only as indicating approximately the point of release. It is in determining these curves that the principal part of the work is done. They are determined from formulas requiring the use of logarithms and in order to enable those unfamiliar with handling logarithms to build the curves, the calculation of a sample diagram will be given.

Before making the computations for the diagram it is necessary to decide either upon the proportion of the compression space to the displacement of the piston or upon the pressure that it is desired to have after compression. In practice the charge is compressed to pressures varying from 40 lbs. per sq. in. to 120 lbs. per sq. in. Suppose, therefore, that an average case is taken as an example and that the compression space for the problem in hand is to be 30% of the cylinder displacement; the charge will then be reduced in volume from that of the cylinder when the piston is at the extreme outward limit of its stroke to the volume of the compression space. During compression a small amount of heat is derived from the cylinder walls so that the curve does not follow the theoretical one, but is approximately of the form to be obtained from the following equation:



Machinery, N. Y.

FIG 11

$$P V^{1.3} = K \quad (1)$$

Wherein P = the pressure above a vacuum or absolute pressure.

V = the volume of the gases at the time they are at the pressure P.

K = a constant.

For convenience, the volume of the cylinder when the piston is at the extremity of the outward stroke may be taken as unity and then the constant for the compression curve becomes the pressure of the atmosphere or 14.7. The pressure of the gases after explosion is, for natural gas, four times the pressure after compression. This gives the point of maximum pressure or the upper limit of the straight line. From the maximum pressure is derived the expansion curve which follows very closely that given by the equation

$$P V^{1.35} = C \quad (2)$$

Wherein P and V have the same significance as in equation (1) and C is a constant depending on the maximum pressure.

These equations may also be written as follows:

$$P V^{1.3} = P_1 V_1^{1.3} \text{ and } P V^{1.35} = P_1 V_1^{1.35}$$

This is perhaps a more convenient form to remember, as it shows the relation between any two points on the curves.

To begin the computation, the ratio of the compression space to the total cylinder volume must be found. The compression has been taken as .3 of the piston displacement and the total cylinder volume is the piston displacement plus the compression space or 1 + 3 = 1.3 times the piston displacement. The required ratio will then be $\frac{.3}{1.3}$ = .2308 nearly. The total cylinder volume will be taken as unity and the compression space will then have a volume equal to .2308. To find the pressure at the end of the compression stroke apply formula (1) and the computation is as follows:

$$P V^{1.3} = K = 14.7 \text{ and } P = \frac{14.7}{V^{1.3}} = \frac{14.7}{(.2308)^{1.3}}$$

In order to find the denominator of this fraction it is necessary to multiply the true logarithm of the number by 1.3. The logarithm of .2308 as found in the table (the tabular logarithm) is $\bar{1}.363236$, and since the logarithm has a negative characteristic (number to left of decimal point), the true logarithm must be found by adding the mantissa (number to right of decimal point) to the characteristic thus:

```
− 1.000000
   .363236
 ─────────
   .636764
       1.3
 ─────────
   1910196
  636732
 ─────────
   .8277510
 ─────────
```

$\bar{1}.172249$ (subtracting from 1.000000 and adding − 1 to get the tabular log.).

Log. 147 = 1.167317 and subtracting the last found log we have that of the pressure at the end of the compression stroke thus:

```
 1.167317
 1.172249
 ────────
 1.995068
```

$\bar{1}.995068$ = log of 98.87 = compression pressure in lb. per. sq. in. above a vacuum. Call it 98.9, then the gauge pressure would be 98.9 − 1.47 = 84.2 lb. per sq. in.

To get the maximum pressure this amount is multiplied by 4 and the result is 84.2 × 4 = 336.8 lb. or 351.5 lb. absolute.

It is best to calculate at least three intermediate pressures in order to get sufficiently close to the proper shape of the curve. The pressures when the volumes of the gases are .35, .5 and .75 will usually give a sufficient number for the purpose. The corresponding pressures are found in the same manner as the compression pressure and are 57.6, 36.2 and 21.4 respectively, all being measured from vacuum. The pressures for the compression curve having been found, it remains to determine those for the expansion curve. Using formula (2) it is necessary to first find the constant or the pressure when the volume is equal to 1. Hence $PV^{1.35} = C$ becomes $351.5\,(.2308)^{1.35} = C$.

Log. $(.2308)^{1.35} = 1.1404102$, found in the same manner as log. $(2308)^{1.3}$ above. Log. $351.5 = 2.545925$ and this log added to that of $(.2308)^{1.35}$ gives that of the constant, thus:

$$\begin{array}{l} \bar{1}.1404102 \\ 2.545925 \\ \hline \end{array}$$

$1.686335 = \log.\ 48.57 =$ the terminal pressure of the gases in case release takes place at the end of the stroke. And the equation of the expansion curve becomes $PV^{1.35} = 48.57$.

The intermediate pressures at the volumes .35, .5 and .75 are found from this equation in the same manner as for the compression curve, and they are 200.4, 123.8, 71.6. No attempt has been made to carry these figures beyond one decimal place.

The diagram is built up from these figures as shown in Fig. 11.* Vertical lines are drawn at distances from the line D C proportionate to the distances .23, .35, .5 and .75, the scale of the diagram being 5" = unit volume on the horizontal lines and 1" = 100 lb. on the vertical lines. In order to properly complete the diagram, the short curves at i and at r e should be added The curve at i represents that produced by the rise of pressure due to the ignition of the gases before the end of the compression stroke and it can be drawn approximately only, as it varies in size for any change in piston speed. Its effect upon the area of the diagram is so small as to make it of little moment save as a memorandum when comparing this diagram with those obtained from the engine itself. The curve r e is that due to release taking place in time to bring the point e where the expansion line meets the atmospheric line A B, at the end of the stroke. To construct this curve draw the vertical line r s at a distance from X m equal to .9 of the length of the diagram, in this case .9 × .77 equal to .693 from X m. Through r draw a circular arc tangent to the expansion line and passing through the point e. Drawing curves through the points already determined and a straight line from i to m completes the diagram. The line X Y is the vacuum line and it is from X Y that all the pressures on the right of the vertical line are measured. In order to get the gauge pressures subtract 14.7 from the absolute pressures or measure from the atmospheric line A B.

The mean effective pressure may be found from this diagram in the usual manner by measuring its area with a planimeter and dividing this result by the length of the diagram. The area of the diagram is 3.272 sq. in., its length 3.85 in. and the area divided by the length is .85, and since the scale of pressures is 100 lbs. to 1 in. the M.E.P. is 85 lb. per sq. in. The diagram also serves as an index of what is taking place in the cylinder at any time during the cycle, and will in many instances save guess work on the part of the designer.

Taking this diagram as a basis of operations, suppose it is required to design an engine which will give 40 brake horse-power (B.H.P.) when using natural gas as a fuel. The mechanical efficiency of an engine of this size may safely be taken as 85%, hence the indicated horse power (I.H.P.) of the engine should be 40 ÷ .85 = 47.06 say 47 I.H.P.

In order that the reader may fully understand every step of the process, and also be able to build up a formula of his own, should occasion require, the derivation of a specific formula from the general equation for I.H.P. will be given in its entirety. Both practice and theory have finally agreed that the best proportions for a four cycle gas engine cylinder are obtained when the stroke is made 1½ times the diameter of the cylinder. Practice seems also to indicate a limit of 600 ft. per minute for the speed of the piston. This, it is as well to note, is surpassed in some of the more modern vertical engines, but higher speeds than 600 ft. are unusual. The principal dimensions of the engine being based upon that of the diameter of the cylinder, it is most convenient to determine the diameter first.

The general equation for the I.H.P. of a gas engine is:

$$\text{I. H. P.} = \frac{Plan}{33{,}000} \quad (3)$$

In which $P =$ M.E.P.

$l =$ length of stroke in feet.

$a =$ area of the cylinder in sq. in.

$n =$ number of explosions per minute.

For convenience the following symbols will be employed throughout this series of articles :

$D =$ diameter of the cylinder in inches.

$L =$ length of stroke in inches.

$R =$ revolutions per minute.

Since $L = 1\tfrac{1}{2}\,D$ and $l = \dfrac{L}{12}$, $l = \dfrac{D}{8}$

$$a = \frac{3.1416D^2}{4}$$

The piston speed being 600 ft. $R = \dfrac{600}{2l} = \dfrac{600}{\frac{D}{4}}$. and since $n = \dfrac{R}{2}$,

$$n = \frac{600}{\frac{D}{2}} = \frac{1200}{D}.$$

By substituting these values in equation (3) it becomes:

$$\text{I. H. P.} = \frac{P \times \frac{D}{8} \times \frac{3.1416\,D^2}{4} \times \frac{1200}{D}}{33{,}000}$$

Simplifying this expression it becomes:

$$\text{I. H. P.} = .00357\,P\,D^2 \text{ and } D^2 = \frac{\text{I. H. P.}}{.00357\,P}, D = \sqrt{\frac{\text{I. H. P.}}{.00357\,P}} \quad (4)$$

For the engine under consideration this formula gives:

$$D = \sqrt{\frac{47}{.00357 \times 85}} = 12.45 \text{ say a } 12\tfrac{1}{2} \text{ inch cylinder.}$$

The length of the stroke is 3/2 D = 18¾ in.

The revolutions per minute are 600 ÷ 3.125 = 1.88 nearly.

These results show what the dimensions of the engine should be to give 40 B.H.P. when working to best advantage. To many gas engine designers these dimensions will appear small for a 40 B.H.P. engine, but the writer has seen an engine proportioned according to equation (4) do even better on the testing floor. For the smaller powers it is necessary to employ a mechanical efficiency of 80%.

The constant in equation (4) becomes .00407 for a piston speed of 700 ft. per minute, a speed that is sometimes adopted for vertical engines of large powers.

A very common basis for the design of gas engines is an M.E.P. of 70 lb. per sq. in. With such a basis the cylinder diameter of the engine just considered would be:

$$D = \sqrt{\frac{47}{.00357 \times 70}} = 13.7 + \text{say } 13\tfrac{3}{4} \text{ in.}$$

The length of the stroke would be 3/2 D = 20,62 in., say 20¾ in.

The r.p.m. 600 ÷ 3.46 = 173 r.p.m., say 175 r.p.m.

Suppose that instead of a four cycle engine it was a two cycle engine that was to be designed. Since these engines have an impulse, each revolution formula (4) would evidently become:

I. H.P. $= .00614PD^2$ for an engine having a stroke = 3/2 D.

But as these engines are seldom built in large powers, this formula would give too high a piston speed. Even formula (4) gives a piston speed higher than is customary for engines under 40 B.H.P. The piston speed of small engines is always lower than it is for engines of large powers, because it gives the engine too high a rotative speed at the crankshaft. The relation between the horse-power of a gas engine and the r.p.m. of the crankshaft can be determined from the following empirical formulae which are based on the average practice of gas engine builders in the United States.

$$\text{For a four cycle engine, } R = \frac{350}{(H)^{.91}} \quad (5)$$

$$\text{For a two cycle engine, } R = \frac{405}{(H)^{.91}} \quad (6)$$

Wherein $R =$ r.p.m. of the crankshaft.

$H =$ the brake horse-power of the engine.

The following formulae for the B.H.P. of a gas engine will also be found a convenience in the calculation of the principal dimensions.

$$\text{For a four cycle engine, } H = \frac{D^2 \times L \times R}{19{,}000} \quad (7)$$

---

* The diagram as shown is slightly smaller than the true scale.

$$\text{or a two cycle engine, } H = \frac{D^2 \times L \times R}{10{,}000} \quad (8)$$

mbols in these equations are the same as given else- this article. The formulae are deduced from the prac- merican builders and represent, with a mechanical effi- 80%, a M.E.P. of 66 lb. per sq. in. and 63 lb. per sq. in. ely. They give very safe figures for the dimensions of ısing gasoline or natural gas for fuel, but from the the formulae there is no allowance for variation in ion.

bject of compression pressures is one of the most im- n the whole subject of gas engine design. The higher sure, the better the economy of the engine, but with of this pressure come serious difficulties and frequently ed ones. As the pressure of a gas is increased the ure is raised and a temperature is reached at which ge will take fire from the rise of temperature due ression. This is especially true when the tempera- the cylinder walls is not kept down to a proper d an excessive amount of heat is derived from ce. This leads to the subject of "back-firing" or e ignition, an extremely annoying feature. In many wever, this trouble may be traced to other sources. here be a projection of any sort within the cylinder, very thin, it may become heated to a high tempera- act in the same manner as does an ignition tube, but difference that it is likely to, and usually does, ignite ge before the proper time and quite frequently during on stroke. A still more prevalent cause of premature s a deposit of carbon on some projection on the piston. on will reach a high temperature and when it becomes to ignite the charge before the proper time, the trouble It is to these deposits of carbon that much of the due in engines using high compression. The way to m is first to make sure that there are so few projec- ossible extending into the cylinder and that none what- ect from the piston. It is also important that the cylinder should be of such a nature that it will not deposit car- aring this feature in mind it at once becomes apparent gniter electrodes should be placed in the path of the en- ses and that the igniter plug should be so placed that be conducted away from it as rapidly as possible. It is that the gas engine builder has recognized the impor- jacketing the exhaust valve and it is time that he should nportance of carrying off heat from projections into the This matter is assuming more importance at present f the tendency to high compression pressures which is urbing the gas engine designer.

rn to the subject of dimensions and to the use of equa- , (6), (7), (8) and (9), suppose that it is intended to engine of 10 B.H.P. and of the four cycle type. It is to first determine the speed from equation (5):

$$R = \frac{350}{(10)^{.21}} = 216 \text{ r. p. m.}$$

eration is as follows:

$= 1.000000$, log. $(10)^{.21} = .210000$, log. $350 = 2.544068$, $- .210000 = 2.334068 =$ log. 215.8 or 216 for an even A more convenient figure than 216 would be 220 and ture from that given by the equation is too small to be t. Adopting this figure for the r.p.m. of the crankshaft, step is the determination of the cylinder diameter from (7). The ratio of the length of the stroke to cylinder will be taken as in the former problem $L = 3/2\ D$ and (7) becomes:

$$\frac{D^2 \times 220}{\times 19{,}000} = \text{and } D^3 = \frac{10 \times 2 \times 19{,}000}{3 \times 220},\ D = \sqrt[3]{575.86}$$

32 nearly, call it 8⅜.

/2 $D = 12$ 9-16, or as the required dimension has been in the diameter, 12½ in. will be sufficient for the stroke. rincipal dimensions of the engine will then be 8⅜ in. by 12½ in. stroke, and the r.p.m. 220. Checking these y means of formula (7):

$$= \frac{D^2 \times L. \times R}{19{,}000} = \frac{(8\tfrac{3}{8})^2 \times 12\tfrac{1}{2} \times 220}{19{,}000} = 10\ 15.$$

This check shows that the proportions of the engine are ample to give the required 10 B.H.P. on natural gas. For gasoline the B.H.P. obtainable would be about 10% higher or 11 B.H.P.

It has been the custom in the past for manufacturers to rate their engines at a horse-power equal to about two-thirds of what they would give on natural gas when working at their best. There are many arguments for and against this custom, and each side of the question has good points in its favor. With the exception of gasoline, the quality of gaseous fuel varies with the locality, a cubic foot of gas representing all the way from 1/12 horse-power hour down. If an engine is rated at 15 B.H.P. for natural gas, it may not give more than 10 B.H.P. on some qualities of city gas. Again, it is not thought expedient by many to run an engine at more than three explosions to one miss for its normal load or at ¾ of its power when working to its full capacity. This makes an allowance for overload, which is quite an important consideration. On the other hand, a gas engine gives better economy when operating at full load, and it is often advisable to so divide the power between two or more engines that those running may carry, as nearly as possible, their full load. The balance of opinion seems to be in favor of rating the engine sufficiently below its best operation to allow a reasonable margin for overload. Many makers fight shy of this question by insisting upon knowing just what the engine is to drive and to then recommend a suitable size. It is always a good argument to the average power user for an engine to give more than claimed for it by the maker. Any falling off, however, appears to these persons inexcusable no matter what the circumstances may be. It is, by all odds, the safest plan to rate an engine below what it is capable of and to make economy guarantees only on the basis of what the engine is to be used for.

The denominator of the fraction in equations (7) and (8) may be changed to suit the basis of an entire series of designs. Thus if it is found that a number of engines which have been built according to some fixed shop rule will give as this denominator 21,000, it is quite safe to assume that the dimensions of other sizes may be based upon a formula the numerator of which is the same as that in equation (7). Suppose that in a certain factory there has been built an engine having a cylinder diameter of 11½ in. and a stroke of 17 in. gave 20 B.H.P. when running at 185 r.p.m. Calling the required denominator X, the equation would stand

$$20 = \frac{(11\tfrac{1}{2})^2 \times 17 \times 185}{X},\ X = \frac{(11\tfrac{1}{2})^2 \times 17 \times 185}{20} = 20{,}800 \text{ nearly,}$$

and the equation for this set of engines becomes:

$$H = \frac{D^2 \times L \times R}{20{,}800}$$

In the design of two cycle engines, the ratio of the cylinder diameter to the stroke is quite frequently 1, and the stroke is seldom more than 1.25 times the cylinder diameter. If the former ratio is taken as the basis of computation of the principal dimensions, equation (8) may be simplified to

$$H = \frac{D^3 \times R}{10{,}000} \quad (8a)$$

For example, suppose it is required to find the diameter of the cylinder for a two cycle engine of 12 B.H.P. Using equation (6) to find the speed it becomes:

$$R = \frac{405}{(12)^{.21}}$$

Log. $12 = 1.079181$, $1.079181 \times .21 = .22662801$.

Log. $405 = 2.607455$ and subtracting from this the log just found

$$\begin{array}{r} 2.607455 \\ .226628 \\ \hline 2.380827 \end{array} = \text{log. } 240 +$$

Using equation (8a)

$$12 = \frac{D^3 \times 240}{10{,}000},\ D = \sqrt[3]{\frac{12 \times 10{,}000}{240}} = \sqrt[3]{500} = 7\ 937, \text{ say 8 in.}$$

Then since the stroke is equal to the diameter of the cylinder the engine should be an 8 × 8, and the r.p.m. 240.

*(To be continued.)*

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The first article of this series appeared in the November issue.

## SHRINK AND PRESS FITS.

### DISCUSSION FROM BOTH THEORETICAL AND PRACTICAL STANDPOINTS.

Henry Hess

A question that has troubled many a mechanic and designer is that of the proper allowance to be made between a pin and hub when these are to rely on their grip only for steady company.

To resort to the handbooks does not bring much light.

Kent f. i. on page 973 says, on Colemian Sellers' authority, that 30 to 35 tons were required to press a 4.015 axle into a 4 in. bore; but he says nothing as to the force that would be required to separate these parts, which is, after all, the thing that a designer would most like to know.

Another quotation of Kent's on page 973 from the "American Machinist," gives a rule for the pressure required to force the parts together as:

$P = 6\ D$ for perfectly true and smooth holes.

$P = (6 \text{ to } 9)\ D$ for untrue or rough holes where $D$ = diam. in inches.

$P$ = total pressure in tons required for assembling.

But here no clue is furnished as to the difference of diameter to be allowed and again no mention is made of the cohering force of the assembled parts.

On looking up other authorities I picked up first Weissbach-Reuleaux "Ingenieur" in German and on pp. 658 found

$$Q = 2 \pi r l S_1 f \ldots\ldots (1)$$

$$\frac{S_2}{S_1} = \frac{1}{v} \text{ if } v = \frac{\left(1 + \frac{t}{r}\right)^2 - 1}{\left(1 + \frac{t}{r}\right)^2 + 1} \ldots\ldots (2)$$

and a table to aid solution, which, however, is not quoted, as it is for the present immaterial.

$Q$ = force required to force in the hub at the last moment.
$l$ = length of hub.
$r$ = radius of pin when compressed.
$t$ = wall thickness of hub.
$S_1$ = compression stress on the pin.
$S_2$ = tensile stress in the hub.
$f$ = co-efficient of friction; assumed to be 0.2 for the usual metals in a dry state.

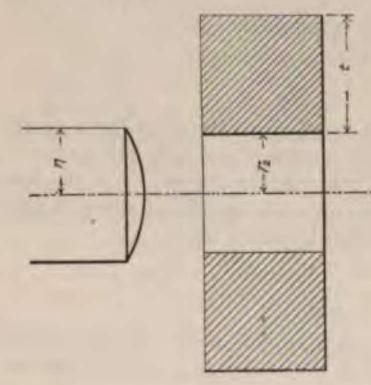

FIG. 1.

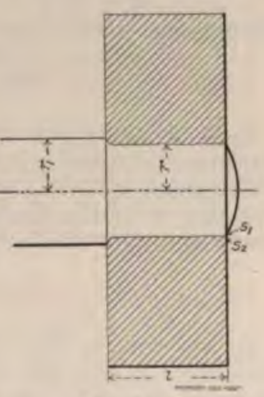

FIG. 2.

Now this begins to look as though there might be something in it—at any rate it takes into consideration the length of the hub, which certainly must affect the holding power. It is plain that if we have a narrow hub gripping a pin with a certain force, a second similar hub will grip with the same force and it will take twice as much pull to remove both hubs at once as it would to remove only one. The nature of the resistance to forcing on or off is undoubtedly frictional, somewhat complicated by a shearing or smoothing down of mechanical irregularities of the surfaces; this also is here taken into account by the introduction of the value "f". A little consideration will make it evident that the relation of pin to hub thickness will affect the results, since a relatively heavy hub can be made to grip tighter than a light one; the compressive grip must cause tension in the hub, of which a heavy one could stand more. But there is no clue as to the difference of initial pin and bore diameters that should be allowed.

Reference to my "steady company," Reuleaux's Constructeur, edition 1895, page 59 and after, gives what is needed for a complete solution.

Reuleaux approaches the problem somewhat differently in that he determines what original differences of size may exist between the pin and bore diameters without producing undue stresses in pin or hub. By the use of his expressions and those of Weissbach-Reuleaux an answer may be found to all the questions that either the mechanic or designer may wish to ask.

$r_1$ = original radius of the pin.
$r_2$ = original radius of the bore.
$r$ = radius of pin and bore when assembled.
$t$ = hub wall thickness.
$l$ = length of hub.
$S_1$ = compressive stress at the pin surface, where it is greatest.
$S_2$ = tensile stress at the bore surface, where it is greatest.
$E_1$ = elastic modulus of the pin material.
$E_2$ = elastic modulus of the hub material.
$Q$ = force required to force on the hub endwise when just getting home.
$f$ = co-efficient of friction, etc.
$P$ = proportion of pin and bore reduced to difference of radius of unit length.

$$P = \frac{r_1 - r_2}{r_2} \text{ (Reuleaux)} \ldots\ldots 3.$$

$$S_1 = \frac{P E_1}{1 + \frac{E_1}{E_2 v}} \qquad S_2 = \frac{P E_2}{1 + \frac{E^2 v}{E_1}} \text{ Reuleaux 39).}$$

$$P = \frac{S_1}{E_1} + \frac{S_2}{E_2} = \frac{S_2}{E_2} + \frac{S_2 v}{E_1} \text{ (Reuleaux 38).}$$

$$v = \frac{\left(1 + \frac{t}{r}\right)^2 - 1}{\left(1 + \frac{t}{r}\right)^2 + 1} \text{(Reuleaux 37)}$$

| If $\frac{t}{r_2}$ = | 0.5 | 0.6 | 0.7 | 0.8 | 1.0 | 1.5 | 2.0 | 3.0 |
|---|---|---|---|---|---|---|---|---|
| then $v$ = | 0.385 | 0.438 | 0.486 | 0.528 | 0.600 | 0.724 | 0.800 | 0.882 |

Reuleaux uses the conditions when assembled; but for practical considerations, the original wall thickness and reamed (therefore standard and invariable) hole radius $r_2$ is more convenient and has the same practical effect.

These formulae may be accepted as correct for all stresses within the elastic limit, as they are based on the theory of stresses produced in circular elements under circumferential pressure, as worked out by Lame and others and universally accepted for guns, hydraulic cylinders, etc.

Provided now that the co-efficient resistance "f" is known, everything is ready for a solution. It is true that Weissbach-Reuleaux assigns to this the value 0.2 for the usual metals, but it is questionable whether this may be accepted as true in all cases.

In forcing a hub endwise on to a shaft undoubtedly the accidental irregularities that, in practice, are not entirely avoidable at a commercial cost of production, will be more or less smoothed down. It follows that the resistance to pulling off will be less than to forcing in. For a hub shrunk on this consideration falls out, and probably the same co-efficient will apply to pulling off as would apply to forcing on cold. Again the co-efficient or torsional grip will vary. It is quite probable that a hub forced in endwise will have a tighter hold against twisting, than one shrunk into place, because the forcing in may produce longitudinal grooves and elevations that will oppose twisting, while the irregularities raised by the turning tools are in the same direction as the twisting, and so do not oppose it.

Actual tests only can afford the data for determining the value of the co-efficient under various conditions. In the "American Machinist" of Feb. 16, '99, in an article on "Shrink and Force Fits," Prof. John J. Wilmore gives an account of some tests that will serve as a partial clue, and that when analyzed show the variations of the co-efficient under different conditions of assembling and separating.

In the following tables, columns 1, 2 and 3 are those given by Prof. Wilmore, while the others are calculated by the formula noted.

The key to the headings appears in the preceding page.

FORCE JOINTS SEPARATED ENDWISE.

| Number of Specimens. | | Q lbs. | P by Equation 3 | $S_1$ by Equation 39. | $S_2$ by Equation 39. | f by Equation 1. |
|---|---|---|---|---|---|---|
| 1 | 0.5005 | 1000 | 0.0010 | 8990 | 950 | 0.028 |
| 5 | 0.50075 | 2150 | 0.0015 | 13480 | 1420 | 0.040 |
| 10 | 0.501 | 2570 | 0.0020 | 17980 | 1900 | 0.036 |
| 14 | 0.50125 | 4000 | 0.0025 | 22480 | 2370 | 0.0036 |

SHRINK JOINTS SEPARATED ENDWISE.

| Number of Specimens. | $r_1$. | Q, lbs. | P by Equation 3. | $S_1$ by Equation 39. | $S_2$ by Equation 39. | f by Equation 1. |
|---|---|---|---|---|---|---|
| 2 | 0.5005 | 5320 | 0.0010 | 8990 | 950 | 0.150 |
| 3 | 0.5005 | 5820 | 0.0010 | 8990 | 950 | 0.160 |
| 11 | 0.501 | 7500 | 0.0020 | 17980 | 1900 | 0.110 |
| 12 | 0.501 | 8100 | 0.0020 | 17980 | 1900 | 0.160 |
| 15 | 0.50125 | 9340 | 0.0025 | 22480 | 2370 | 0.084 |
| 16 | 0.50125 | 9710 | 0.0025 | 22480 | 2370 | 0.087 |

FORCE JOINTS SEPARATED BY TWISTING.

| Number of Specimens. | $r_1$. | Q, lbs. | P by Equation 3. | $S_1$ by Equation 39. | $S_2$ by Equation 39. | f by Equation 1. |
|---|---|---|---|---|---|---|
| 6 | 0.50075 | 2200 | 0.0015 | 13480 | 1420 | 0.040 |
| 7 | 0.50075 | 2800 | 0.0015 | 13480 | 1420 | 0.053 |
| 13 | 0.501 | 4200 | 0.0020 | 17980 | 1900 | 0.060 |
| 17 | 0.50125 | 1465 | 0.0025 | 22480 | 2370 | 0.016 |

SHRINK JOINTS SEPARATED BY TWISTING.

| Number of Specimens. | $r_1$. | Q, lbs. | P by Equation 3. | $S_1$ by Equation 39. | $S^2$ by Equation 39. | f by Equation 1. |
|---|---|---|---|---|---|---|
| 4 | 0.5005 | 2200 | 0.0010 | 8990 | 950 | 0.060 |
| 9 | 0.50075 | 9800 | 0.0015 | 13480 | 1420 | 0.180 |
| 18 | 0.50125 | 13800 | 0.0025 | 22480 | 2370 | 0.116 |
| 19 | 0.50125 | 17000 | 0.0025 | 22480 | 2370 | 0.141 |

In all the specimens the hole is reamed to 1-inch and the length of hub is 1.25. The probable error of reaming is said not to exceed 0.00025; the probable error of sizing the pins is not known. The hubs were in the shape of flat cast iron discs 6" dia., and 1-inch thick with a ¼" projection on one side of 2" dia. This projection is rather unfortunate as it introduces an element of uncertainty into the mathematical analysis. The projection has a well thickness of only ½", while this disc has a wall thickness of 2½"; different stresses must be produced in these two portions of the disc and also in those portions of the pin they embrace. There must also be a zone of more or less extent over which these stresses tend to equalize. The pins were made of a good quality of machine steel. For the method of conducting the tests the article may be consulted.

**Grip of Force Joints Separated Endwise.**

The allowance per inch or radius varies from 1 to 2.5 thousandths of an inch.

The co-efficient of resistance as determined from the equations with the observed test results inserted varies between 0.028 and 0.0036; it increases with the increase of the forcing allowance. If the co-efficient were one of friction only there should be no such increase; it may therefore be accepted as due to the greater amount of reduction of inequalities or harder burnishing down of the surface.

A further increase of the forcing allowance is accompanied by a decrease of the grip co-efficient. This may be assigned to the increased compression stresses produced as shown under $S_1$, which are evidently too high; for No. 14 at any rate with $S_1 = 22{,}480$ it is very evidently too much.

**Shrink Joints Separated Endwise.**

The allowance per inch of radius varies from 1 to 2.5 thousandths of an inch.

Nos. 2, 3 and 12 show a fair correspondence of the co-efficient of resistance. The marked falling off of No. 11 may be due to some unnoticed defect of the surfaces or material. The marked effect of the increase of allowance in the co-efficient is noticeable until we get again in Nos. 15 and 16 too high compression stresses $S_1$ due to a large forcing allowance.

**Force Joints Separated by Twisting.**

Allowances as before.

Co-efficient of resistance increases with forcing allowance, up to that point where too great an allowance causes the compression stresses in the pin to go too high.

**Shrink Joints Separated by Twisting.**

Allowances as before. See notes immediately preceding.

**Comparison of Force Joints Separated Endwise and by Twisting.**

In both, the co-efficient of resistance increases with an increased difference between pin and bore, up to a certain point where the compression stresses become disadvantageously high. The resistance to separating by twisting is materially greater than to forcing off endwise.

**Comparison of Shrink Joints Separated Endwise and by Twisting.**

Tests do not show any material difference in value of co-efficients of resistance at similar allowances of size differences, and are somewhat contradictory.

**Comparison of Shrink with Force Joints.**

Under similar conditions of separation the shrink joints possess a materially higher co-efficient of resistance.

The general tendency of the deductions regarding the relative qualitative values of the various methods of assembling as to the resulting resistances to separation appears reasonable and in accordance with abstract analysis. Before values may be assigned to the co-efficient of resistance further experiments on the most advantageous allowance for different diameters should be made. In conducting such experiments hubs of a uniform thickness with no disturbing excrescences should be used; the material entering into each pin and hub should be tested; if it were also tested after the experiment that would be of value, though not absolutely necessary. The tests should determine the elastic limits, the strength in comparison of the pin material and in tension of the hub material. A record should also be kept of the force required to assemble the joint, and this be noted at different points as an aid in determining the effect of length of hub; this will then also show the difference between the co-efficient of resistance in forcing on and off. With shrink joints care should be exercised to apply just enough heat for assembling.

One peculiarity shown by the tests cited is the low value of the co-efficient of resistance, which in only a few cases approaches the values commonly assigned to frictional resistances between dry metallic surfaces.

Such a series of tests would be decidedly appreciated by the engineering world, and be of more value to technical students than the ever-recurring pulling apart of pieces of iron in repetition of tests that have been made thousands of times.

* * *

In the report of the Bureau of Steam Engineering for 1899 is reference to the improvements that have been made in large steel forgings for the machinery during the past few years. The specifications for the Maine and Texas, which were drawn up in 1888 and 1889, respectively, required a tensile strength in this steel varying from 56,000 to 70,000 pounds per square inch, with an elongation of from 16 to 20 per cent. in two inches, both depending on where the test piece was taken; while the specifications for new vessels in 1898, just ten years later, require for high grade shaft forgings, nickel steel, oil tempered and annealed, a tensile strength of at least 95,000 pounds per square inch, an elastic limit of 65,000 pounds per square inch, with an elongation of 21 per cent. in two inches. All the shafting for several of the torpedo boats was made of this material, while in the battleships, monitors, and torpedo-boat destroyers, the crank-shafts alone were made of nickel steel, simply annealed, with a tensile strength of 80,000 pounds per square inch, and an elastic limit of 45,000 pounds per square inch, with an elongation of 26 per cent. in two inches, the remainder of the shafting for these vessels being of the higher grade quality previously mentioned. The possibility of thus reducing machinery weight, without a sacrifice of endurance and strength is clearly obvious.

* * *

The quantity of steam that will escape from a boiler into the atmosphere through a small aperture is quite remarkable. An orifice of one square inch area will allow 98¾ pounds of steam per minute to escape from an initial pressure of 100 pounds gauge into the atmosphere. An aperture of only 1-100 of a square inch in area will allow an escape of nearly 60 pounds per hour under the pressures, stated, so it is evident that small leaks are expensive luxuries.

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## JANUARY, 1900.

## CIRCULATION STATEMENT.

The regular edition of MACHINERY for January is 20,000 copies, AMERICAN MACHINERY is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. No papers are sent free except to advertisers, exchanges and circulation agents.

The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

| | |
|---|---|
| The IRON AGE, about | 7,000 |
| The AMERICAN MACHINIST, about | 12,000 |
| MACHINERY | 20,000 |

Owing to a strike among the engravers we were unable to send the data sheet with the December number, as usual, and it is mailed with this number instead. Those who have the September, 1899, data sheet will kindly note that in the second formula under "Centrifugal Force" the "w" is in pounds per cubic foot and that the third formula under this heading gives the number of revolutions per minute.

* * *

It seems to be the prevailing impression among European engineers that the present good times for American machinery builders will be even better after the opening of the Paris Exposition. The conditions throughout Europe at the present time are about the same as in Great Britain and in this country where there is an active demand for all the machinery that can be manufactured. The tendency of continental firms, however, is toward conservatism, and many of them feel disposed to wait before increasing their equipment until their engineers have had an opportunity to examine in person the products of American builders. This they will do during the exhibition. After this examination has been made and reports submitted, the various firms will be in a position to place orders intelligently and there cannot be much doubt that the machine tool builders of this country will obtain their share of the business.

Prof. F. R. Hutton, 12 West Thirty-first street, New York, is receiving subscriptions for the proposed memorial to Robert Fulton, the illustrious engineer who was so actively engaged in promoting steam navigation in the early years of this century. Fulton's remains were placed in the graveyard of Trinity Church, New York, where they have remained neglected and forgotten for over three-quarters of a century. At the Washington meeting of the American Society of Mechanical Engineers, action was taken toward erecting a suitable monument to his memory. The undertaking is in the hands of a committee of this society and no contribution need be considered too small to be sent for the purpose of perpetuating the memory of Fulton's life and work. In fact, it would be more suitable to have the monument erected through the aggregate of a large number of small contributions rather than as the result of a few large ones.

* * *

## THE RIGHTS OF ADVERTISERS.

If a newspaper publisher insisted that an advertiser should pay him a specified sum for an unknown amount of space, how much business would he get? Yet most publishers insist that an advertiser shall pay for an unknown amount of circulation when circulation is vastly more important than space, for without circulation space is valueless.

We contend that an advertiser has the right to know just what he gets from a newspaper for his money; the same knowledge he exacts when he buys coal, or steel, or oil. Would he contract to pay his oil manufacturer a number of hundred dollars a year and leave it to the latter to say how much oil should be supplied for the money? Would he run any other department of his business as some publishers want him to run his advertising department?

It is to the interest of all advertisers to insist on a circulation statement as a part of their contract, and when it is refused they should refuse their business. It is to the interest of all legitimate trade papers to encourage advertisers to exact this information, and thus shut out a mass of schemes and worthless mediums which prey upon manufacturers and absorb a large proportion of their advertising expenditure.

An advertiser who buys space in MACHINERY has only to look on the editorial page every month to know what he gets for his money. He is entitled to this information, and every newspaper he spends money in should give it to him—without asking.

* * *

## BOOK REVIEWS.

It is common practice for publishers to send copies of their new books to the different periodicals that circulate among readers interested in the subjects covered by these books. In acknowledgment of this courtesy, it is expected that a review will be given in the reading columns of the periodicals and thus information relative to the books will be widely circulated.

It is also the common practice of many of these periodicals to give a favorable notice of every book that is received, partly, perhaps, because the publishers of the papers are themselves interested in the sale of books and every favorable review will have a tendency to increase the business of their book departments. On the other hand, it is the policy of some other publications to present a critical review of each book as it appears, in which it is felt that the knowledge of the reviewer is sufficiently displayed, and all the requirements of an impartial review answered, if a few sentences are picked out here and there and pulled to pieces, and various other adverse comments made at random upon different sections of the work.

It is obvious that in the first instance the readers of the periodical are not receiving the consideration they have reason to expect at the hands of a publisher or an editor, whom they patronize regularly as subscribers. Many of them wish to add to their libraries of reference from time to time and in the long run there will be a reaction, and those who have been misguided will no longer have confidence in the paper they formerly relied upon. In the second instance, the position taken by the reviewer is unjustifiable from any standpoint. He does not benefit the reader, the publisher or the author and does the latter a positive injustice. No one can produce a book without defects, and as any two authorities will differ, the fact that a reviewer may differ from an author should make the former careful that he is not influenced too strongly by his own personal preferences.

It is fair to say that in a book review the same critical judgment should be employed that one would use in deciding upon the merits of a machine. A book requires as much labor and careful thought as a complicated machine, and it often takes longer to produce it.

Suppose, for example, that a person desired an engine lathe and sought for information at the hands of one who had actually seen and examined the particular lathe that it was intended to buy. He would want to know, first, about the design and workmanship upon the essential parts of the lathe, and, secondly, whether the person who examined it detected any weak points that would materially detract from the lathe for regular shop work. Instead of getting this information, if he were told that one of the cap-screws in the carriage had been battered by the workman in putting the parts together, that the paint was too light a shade of gray, that the feeds were reversed in the headstock instead of in the carriage, while he, the one who had made the examination, personally preferred to have the reversal in the carriage, and much other irrevelant information, what sort of an idea would be formed of the worth of the lathe? If it were found that the cap-screws were battered throughout, that the feeds lacked power and that the castings were rougn and poorly painted, it might be presumed that other parts of the machine were slighted also. Adverse criticism, however, would not be made if the important parts as a whole came within the bounds of good practice for the purpose intended, even if their design did not meet entirely with the personal preferences of the critic.

In like manner, the only fair way, either to an author, a publisher or the reader of a paper, is to consider a book in its entirety in relation to the purpose for which it was designed. A reader wishes to know, first of all, what a book contains, what ground it covers and what its scope and limitations are. Then, if there are any weak points, like serious omissions or sections that are in error or for other reason would be likely to mislead, he should be told about these. This latter should be done, however, by picking out essentials and not non-essentials.

It is but fair to add, on the part of the reviewer, that it is not always possible to give a book critical study either from lack of time or lack of technical qualifications. No one man can become an expert in all branches, and it is now universally admitted that a man does well to reach the top in one. In any case, however, the aim should be to give as impartial an estimate of the book as time and qualifications will admit, and if there are unfavorable comments the author must remember that if a book contains errors that can be readily detected by a superficial examination, or even a single totally wrong treatment of a fundamental principle, the reviewer may easily obtain the impression that the subject is not well treated.

* * *

A recent consular report from Great Britain states on the authority of an interview with a well-informed machinist that the improvements in machine tools and the benefits resulting from their adoption in that country, have been tremendous within the last three or four years. No machine shop can now be well equipped without tools from the United States—lathes, shaping machines, planing machines, screwing machines, etc. These, not to attempt to enumerate the hundred kinds of hand tools, are being used everywhere throughout the British Islands. You may say that no machine shop worth mentioning in this country is without at least such tools as turret lathes and ordinary lathes of American manufacture. The turret lathe, which is made in many sizes, varying in price from $250 to $1,000, is a typical example of the general convenience of American tools. With the ordinary British lathes, used for the same purposes, workmen lose time in substituting one tool for another which may not be readily found. The turret lathe obviates this delay. A full assortment of tools being fixed in its turret, the workmen can instantly get any tool by a slight turn of the turret. Certain British manufacturers are now turning out machine tools, etc., made exactlv, or almost exactly, after American designs. A firm in Leeds makes a specialty of constructing machine tools and some other labor-saving machinery according to American patterns. This company probably pays a considerable sum in royalties to American patentees.

## EQUATIONS.

An equation is generally defined as an expression of equality between two or more quantities. To many, however, it may seem to be a clearer explanation to show how an equation can be derived from a simple proportion in arithmetic. For example, we know that the areas of two circles are to each other as the squares of their diameters. If one circle is 4 inches in diameter and its area is 12.566 square inches, what is the area of a 5-inch circle? Calling for the time being the area of a 5-inch circle x, we have, by the principle just stated,

$$12.566 : x :: 4^2 : 5^2 \text{ or}$$
$$12.566 : x :: 16 : 25.$$

Now, this expression will have just the same meaning if we draw a line between the first two dots and the last pair of dots, making signs of division of them, and then connect the two upper and the two lower pairs of dots that belong to the middle group, by straight horizontal lines, making a sign of equality. The expression will then be as follows:

$$12.566 \div x = 16 \div 25.$$

This is an equation and it is read, "12.566 divided by x equals 16 divided by 25." It may also be written $\frac{12.566}{x} = \frac{16}{25}$, the fractions indicating division without the sign of division. This equation is solved by multiplying 12.566 by 25 and dividing by 16, just as the proportion given at first would be solved by multiplying the 12.566 by 25 and dividing by 16; that is, by multiplying the two extremes together and dividing by the known mean, giving the same result and requiring the same operations as in the case of the proportion. The great stumbling block with equations is that it is not always clear how to solve them and determine the quantity desired. With proportion it is easier to do this, but proportion does not have the flexibility nor the adaptability of the equation and it is the main object of the science of algebra to show how to use the equation and how to apply it.

* * *

## COLLEGE DEGREES.

A change in the system of giving degrees in engineering is now being considered bv the Armour Institute of Technology, of Chicago, and Prof. C. V. Kerr, Chairman of the Committee on Degrees, is sending out a circular of inquiry to obtain the opinions of engineers on this subject. From this it appears that the institute is now giving the graduates from the four years' course in engineering the degree of Bachelor of Science (B. S.) in mechanical, electrical or civil engineering, as the course may indicate. A number of engineering schools do the same and give the full engineering degree after two or three years' practice, while other engineering schools give the degree (C. E., M. E. or E. E.) on graduation. Two of the questions propounded in the circular are as follows:

(1) Should the engineering degree be considered as merely an academic degree like the B. A., or should it be considered a professional degree like M. D.?

It seems to us that it should be considered as an academic degree, since no amount of purely academic work can make a man an engineer. It is educational and preparatory work, fitting the student for the practical work of his future career. To give a graduate a degree of C. E., etc., is meaningless from a professional point of view. The M. D. degree is a little different, for while these initials added to the name of a newly fledged graduate cannot make him an experienced or efficient doctor, yet their use by unauthorized persons is prohibited by law. Therefore they have some actual meaning, however limited, whereas there is nothing to prevent anybody, graduate or not, from styling himself C. E.

(2) If we consider the engineering degree as professional or descriptive, like the M. D., and merely indicating the nature of the student's intended career, is it proper to grant the engineering degree, M. E., C. E. or E. E., at the end of a strong four years' course?

Under the conditions stated, it might be proper to do this, though it would undoubtedly be better even then to decide that the degree should only be given after practical experience. As we have above stated, however, it does not appear to us that engineering degrees should be considered as "professional." It may be well to point out, in conclusion, that nothing is gained by the profession, the college, or the graduate, by granting degrees too early or too cheaply.—"Engineering News."

# A MODEL DRAFTING ROOM.

## AN EFFICIENT AND CONVENIENT ARRANGEMENT EMBODYING NOVEL FEATURES.

X. Y.

There are still to be found shop managers who fail to appreciate the fact that it is cheaper to make mistakes on paper than in construction; who do their work on the cut and try plan of fitting each piece to its fellows as the work progresses, of necessity rejecting many pieces that fail to come right.

Fortunately the species is fast becoming extinct and the unalterable law of the "survival of the fittest" will soon drive them out of business or into more modern lines.

More numerous, however, are the type who, while admitting the necessity of drawings, look upon them as a necessary evil instead of in their true light of a valuable money-saving device. In many establishments, the drafting room is a little 7x9 affair with a couple of rickety horses and an apology for a board, and therein is installed the draftsman. Some one has said that the primary qualifications of a draftsman are accuracy, clearness and rapidity, but with the above-mentioned type of manager, there is another qualification which far outweighs any or all of these, namely: a willingness to work cheap. With such, work cheap and cheap work are synonymous.

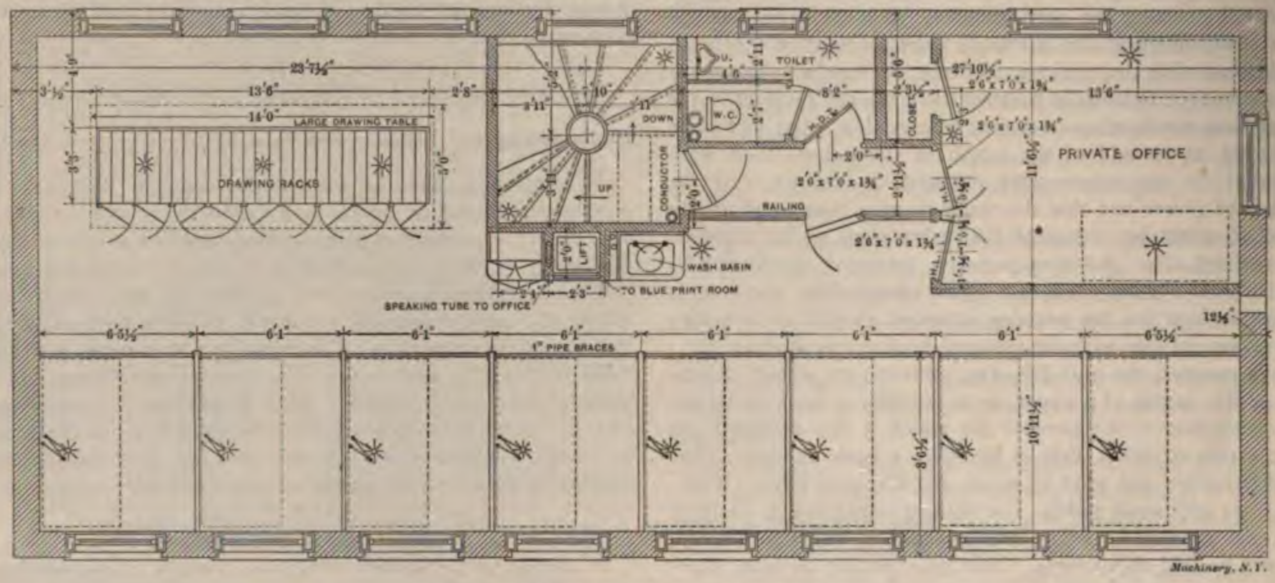


FIG. 1. FLOOR PLAN OF THE DRAFTING ROOM.

Note the situation. A room hot in summer, cold in winter, poorly lighted and ventilated, with the most meager appliances and presided over by the cheapest man that can be found who has assurance enough to style himself a draftsman. What can be expected from such a combination? Would it not be surprising to find anything but poor design and erroneous dimensions emanating from such a place?

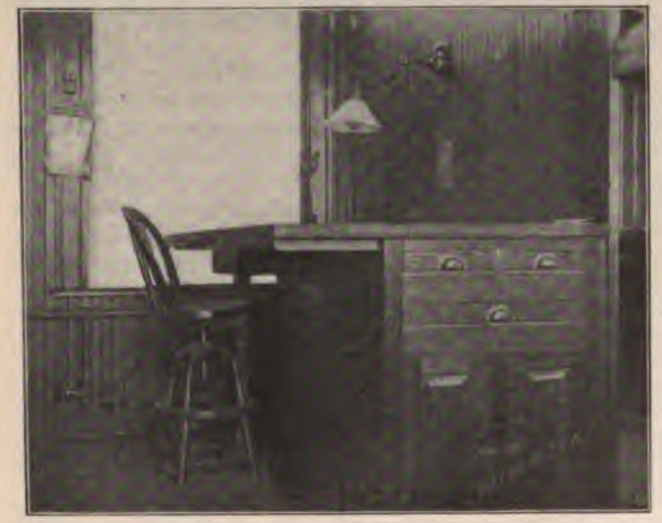


FIG. 2. ONE OF THE PRIVATE COMPARTMENTS.

What wonder that our manager, after a few months' experience with such an outfit, is more than ever inclined to think that the drawing office, drawings and draftsmen, are a piece of tom-foolery, "only fit for those who are so bound up in red-tape that they can't tell Bill to bore a couple of gears for Smith without writing it all out on a card with a red number, a space for weight of the castings, time of the boring, etc.; just as though Bill couldn't tell the book-keeper all about that," provided either of them happened to think of it.

This type, fortunately, is rapidly giving place to the kind of management which organized the drafting department it is our purpose to describe.

Fig. 1 is a floor plan of the drafting room which occupies the entire floor. In one corner is the private office of the mechanical engineer, chief draftsman or whoever is the responsible head of the department. This room has two doors, as shown, one of which opens directly into the drafting room, the other into a passage separated from the drafting room by a railing, and leading to the stairway. On the other side of this passage are the toilet rooms, while the central part of this side of the building is occupied by the winding stairway leading to the floor below and to the blue-print room on the roof. The remainder of this side of the floor is occupied by the large drawing table, of which more later.

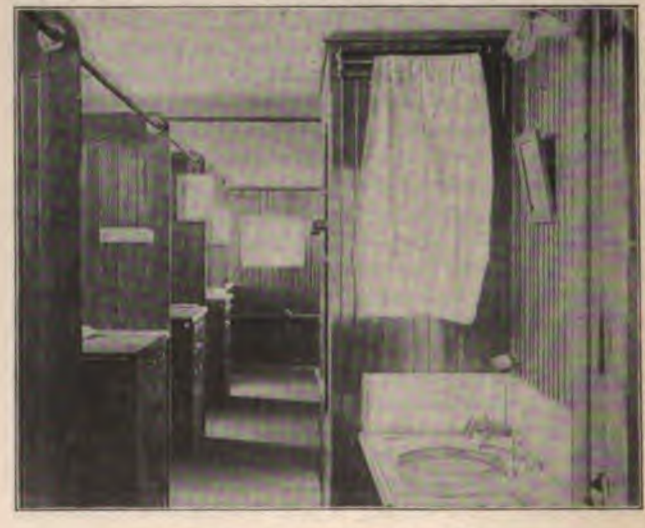


FIG. 3. GENERAL VIEW OF ROOM

The entire west side of the room is divided into compartments, or stalls, as the boys call them, by partitions 7' high and extending about 8' 6" from the wall. This gives to each man a separate compartment 8' 6" x 6' 1" and isolates him, in a measure, from his fellows, obviating, to a large degree, the liability of having his attention distracted by the movements of the others. In each compartment is a table 3' 6" x 8' 0", supported at the inner or left-hand end, by two legs and having a cabinet under the other for storage of reference books, sketches, unfinished drawings, etc., while in front at the center is a drawer with lock and key, fitted with tills for drawings, tools, pencils, tacks, colors, brushes and all articles in more less constant use.

Each compartment has a window with a shade which draws up from the bottom, and an incandescent electric light on a swinging bracket attached to the partition over the center of the table.

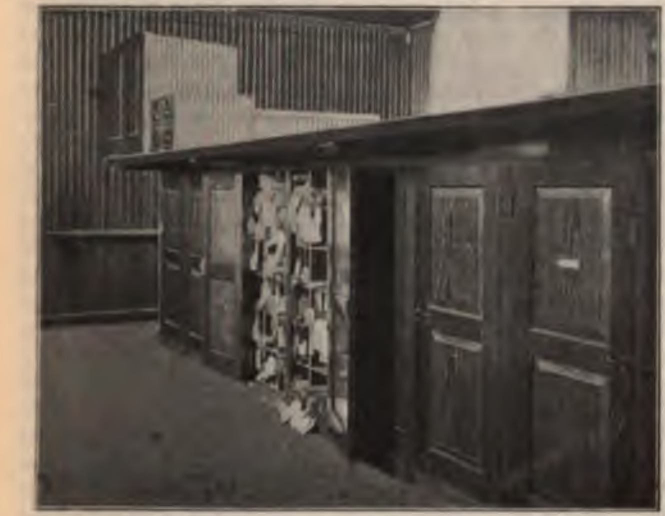


FIG. 4. LARGE DRAWING TABLE WITH PIGEON HOLES AND FILES.

Fig. 2 is a photograph of one of these compartments. It will be seen that each man has ample room to work and a convenient place to keep everything in the way of data, unfinished drawings, and all the things incident to his work, without allowing them to lie around in sight and in the way. This makes it possible to keep the room clean with a minimum of labor and greatly facilitates the work, while being, at the same time, conducive to neatness and accuracy.

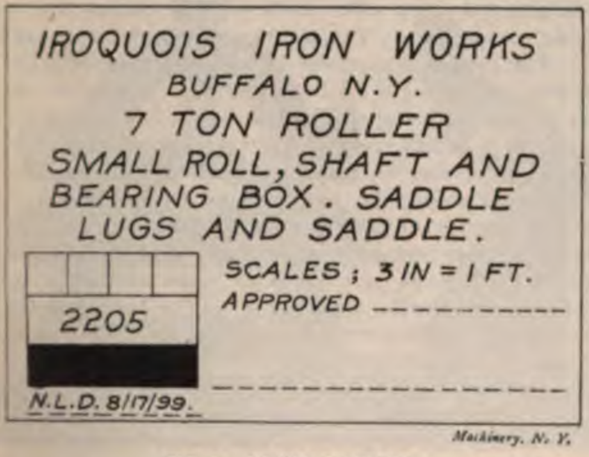

IROQUOIS IRON WORKS
BUFFALO N.Y.
7 TON ROLLER
SMALL ROLL, SHAFT AND
BEARING BOX. SADDLE
LUGS AND SADDLE.
2205
SCALES ; 3 IN = 1 FT.
APPROVED ----------
N.L.D. 8/17/99.
Machinery, N. Y.

FIG. 5. STANDARD TITLE.

In each compartment is an electric buzzer, seen to left of the window in Fig. 2, which is connected by a push button with the desk of the mechanical engineer and also with that of the manager on the floor below, while a speaking tube alongside the dumb waiter affords means of communication with either. In calling a man, his button is pushed in conformity with the Morse code corresponding to his initial, with an additional signal which calls him to the speaking tube or to the desk of the mechanical engineer or manager.

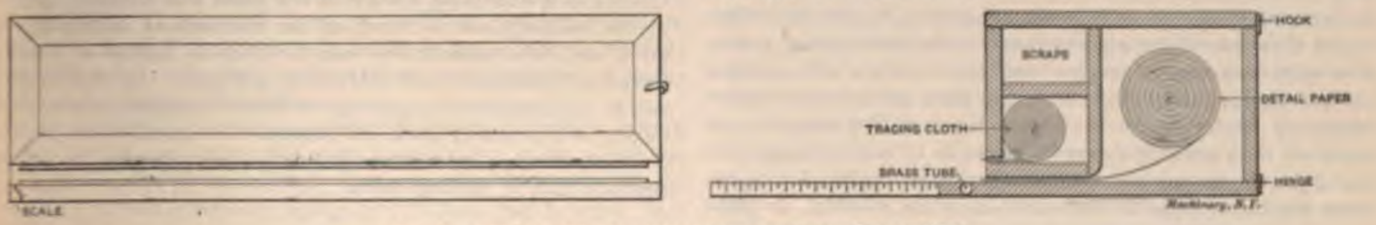


FIG. 8. DETAILS OF BOX FOR PAPER AND TRACING CLOTH.

Fig. 3 is a view taken from the door of the private office and, in connection with Fig. 1, gives a good idea of the general appearance of the room. The large drawing table which occupies the space on the east side of the room beyond the stairway is more properly a case for the filing of drawings and tracings. Fig. 4 shows its construction. The front is divided into compartments, lettered from A to I, inclusive, and each compartment into 18 pigeon-holes for the reception of drawings which are rolled and placed therein.

The Standard Title, Fig. 5, is placed in the lower right-hand corner of the drawing, and the same corner is folded over for about half an inch, and an eyelet inserted for the attachment of the filing tag, Fig. 6. The small square in the lower left-hand corner of the standard title is divided into three parts. The middle one is for the drawing number, the lower one is black, showing white on blue print, for the insertion of a blue print number, while the upper one is divided into small squares for the insertion of re-issue letters. In the original drawing these re-issue squares are blank. Should alterations be made, the letter B is inserted in the left-hand square, while a note, with date, is added calling attention to the alteration. Subsequent alterations are denoted by insertion of C, D, E, etc., with appropriate notes always dated.

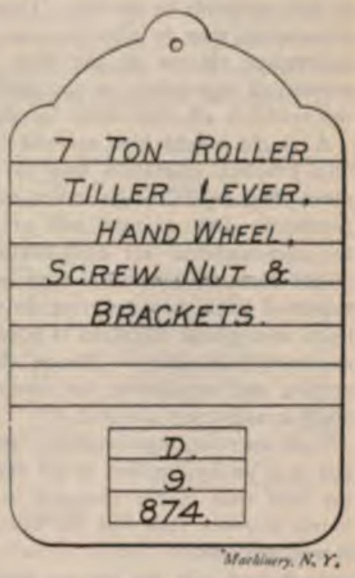

7 TON ROLLER
TILLER LEVER,
HAND WHEEL,
SCREW NUT &
BRACKETS.
D.
9.
874.
Machinery, N. Y.

FIG. 6. FILING TAG.

The filing tag, Fig. 6, is ruled on both sides with horizontal lines for the title of the drawing, as shown, while the small square at the bottom is divided into three parts for compartment letter, pigeon-hole number and drawing number respectively.

| D. | TEN TON ROLLER. | |
|---|---|---|
| 1 | Crank Shaft, Connecting Rod. | R. E. G. |
| 923 | Eccentric Rods and Strap, | ............ |
| ............ | Eccentric Sleeve and Traveller | 1-17-95 |
| ............ | ............................................ | ............ |
| ............ | ............................................ | ............ |
| ............ | ............................................ | ............ |

FIG. 7. FILING CARD. (ORIGINAL ABOUT 3 X 5 INCHES.)

On top of filing case, Fig. 4, may be seen a globe card case with four drawers, which is used as a card catalogue of the drawings. Two drawers are used for consecutive numbers, while the other two are divided by index cards into groups corresponding to the various machines manufactured. This gives two cards for each drawing on file, making it easy to find a drawing if either its number or title be known.

The cards, Fig. 7, are filled out with the compartment letter, pigeon-hole number and drawing number in the left-hand margin. The top line of the body of the card contains the name of the machine to which the drawing belongs, while below are full details as to what part or parts are shown on that sheet. In the right-hand margin are the initials of the draftsman and date. On top of the drawing case, behind the card catalogue, can be seen the top of a case for detail paper, tracing cloth, etc. This is shown in detail by an outline drawing, Fig. 8, and forms a very convenient receptacle for these articles, keeping them clean and in good condition. When either paper or cloth are wanted, all that is necessary is to catch hold of the edge and draw out the requisite distance, as indicated by the attached scale, and cut off by inserting the point of a knife in the slot in the tube.

We are aware that there is, perhaps, nothing in use here that is new or original, but the point which we wish to emphasize is the effort on the part of the management to keep posted on what others are doing and to adapt whatever is good in their methods to our use. They realize fully that the drafting department may be either a source of great expense with very inadequate returns or the most profitable department in the works, all depending on the ability of the men employed and the facilities afforded them for their work.

A single bright idea evolved in the drafting room and put into practical operation may in a single year effect a saving more than equal to the entire cost of maintenance of the department. But no man will or can do his best work where the surroundings are not conducive to bodily comfort. No bright ideas in machine design or constructive details need be expected from men suffering from excessive heat or cold, nor from men whose attention is constantly being distracted by the movements of others. Hence, the careful attention to proper heating and ventilation, the scrupulous cleanliness and the isolated arrangement adopted.

Such surroundings naturally attract and hold the best men, and it is an axiom that in all departments of mechanical work the best man is the cheapest in point of output. It will be found in every case that the money expended in such facilities is well invested.

As before said, we lay no claim to originality in the above and doubt not there are many drafting departments far in advance of this, and if this sketch has the effect of calling forth criticism or a description of more satisfactory arrangements or methods we will consider our time well spent.

* * *

## RECENT DEVELOPMENTS IN THE HALIFAX (ENG.) DISTRICT.

JAMES VOSE.

The tool-building trade of Halifax and district, Yorkshire, has within the last few years entered upon a new phase of activity, and bids fair to furnish a very appreciable share of Great Britain's present and future output of high class machine tools. Though any amount of the low-priced tools, for the production of which Yorkshire has for many years been widely known, may, on demand, still be obtained in Halifax, quite a number of Yorkshire tool builders have definitely determined to lay themselves out for the production, on modern lines, of substantial and well finished tools. In fact, one of the representatives of a well-known firm handling the higher grade of English and American tools recently informed me that, in his opinion, a larger percentage of really high class machine tools is being laid down in the Yorkshire tool-making centers than in the Manchester district. One result of the present prosperity in the engineering trade, as a Halifax manufacturer remarks, is that people have ceased quibling about a few dollars in the price of a machine, and now, from quarters where a year or two ago a matter of five or six dollars would have turned the scale in favor of the lower-priced article, it is quite common to receive inquiries for tools with machine cut gearing, and to have the increased price paid without demur. Messrs. J. Butler & Co. have from January, 1899, supplied cut gears on their tools at the same prices as formerly charged for cast gear. A special gear-cutting department equipped with the latest machinery helps to make this departure possible. In addition to gear-cutting machinery several heavy American milling machines are in use, also planers, shapers, and drills. In this connection it is noted by the firm in common with others I have spoken with, and which my own experience confirms, that however admirable American cast-iron may be for purposes of rapid machining, it does not show to great advantage as regards durability in comparison with English cast-iron when used for working surfaces. For instance, the sliding surfaces of an American planer satisfactory in other respects, were found to wear so rapidly, that a month or two after starting up, it was necessary to take out the rack, and plane the back of it, as the platen was riding on the pinion more than on the bed. This operation has since been repeated. In a case under my own observation, the teeth of the rack pinion of an American shaper were worn more in five or six months than those of an English machine of the same stroke and doing the same work, in as many years. It is a fact not yet grasped by many American makers, that the English metal imposes a much more severe test on the durability of machine tools than does the American. On the other hand, it would probably pay English manufacturers to look more closely into the matter of obtaining metal adapted for rapid tooling in cases where wearing properties are not particularly in question. Messrs. Butler are the makers of a varied line of tools, and though fully aware of the advantages of specialization, they, like many other British firms, will "make haste slowly" in that direction, as there are many solid indirect advantages in being prepared to give a customer just what he requires. Messrs. C. Redman & Sons, a concern managed by several brothers of a progressive bent, could give points to many much more pretentious shops. Practically all their gearing is machine cut, and no expense has been spared in obtaining good tools for their own use. The gear cutting department has come in for careful study, Brown & Sharpe machines being the most used. The effort to obtain maximum production in regular runs of work, such as lathe change wheels, has introduced several interesting problems in machine-tool designing which I have no doubt Messrs. Redman will solve satisfactorily. One American lathe obtained by the firm beat the record for bad design and construction. It was hopeless to attempt to improve it, and in the course of a few weeks was disposed of for a nominal sum. It is a pity this class of tool ever leaves its original obscurity.

This works is all on one floor, with the exception of the pattern shop and drawing office which work in conjunction under the same management. This arrangement works very satisfactorily. The pattern department being some distance from the main shop, its shafting is electrically driven. A specialty of this firm is planing machines, arranged, as a rule, to run at 20 ft. cutting, and 80 ft. return speeds. Another of their lines is a lathe containing a number of American features, including the inverted vee bed apron, etc., but retaining several characteristics of English practice. I have not seen this lathe at work, but can testify to the easy and satisfactory working of the planers. A feature of the last two or three years is the number of works started on a small scale, but fitted up in the best style for the manufacture of milling cutters, reamers, etc. Messrs. R. E. Hattersley & Co. represent this tendency in Halifax and are turning out some good specialties in the way of expanding reamers, and special small tools to customers' requirements. It is worth noting that the goods of this class of manufacture are being sold in competition with and in several cases by the same agents as leading American lines.

At the works of the Campbell Gas Engine Co., Halifax, is a very good collection of modern tools, including examples of English, Scotch, American and Swedish machines. In consequence of increasing business, a considerable extension of the productive facilities has become imperative and is being rapidly carried out on well-considered lines.

The substantial character of every description of building in Halifax is a noticeable feature of the town and district. Most of the buildings are of stone, to the comparative exclusion of brick, and this substantiality may be taken as typical of Yorkshire, its inhabitants and industries generally. In the future keener competition in supplying the world's material needs, this quality will probably stand its possessors in good stead, being conducive to the acquirement of a desirable equipment for most contests, that is, staying power.

* * *

Tests on aluminum wire, recently made at the Massachusetts Institute of Technology, showed an ultimate strength of 26,000 to 27,000 pounds per square inch and an elastic limit of 12,000 to 18,000 pounds. It is probable that aluminum, not in the form of wire, would be considerably weaker, owing to the fact that wire, which is made very dense in the process of manufacture, is always stronger than larger bars of the same material.

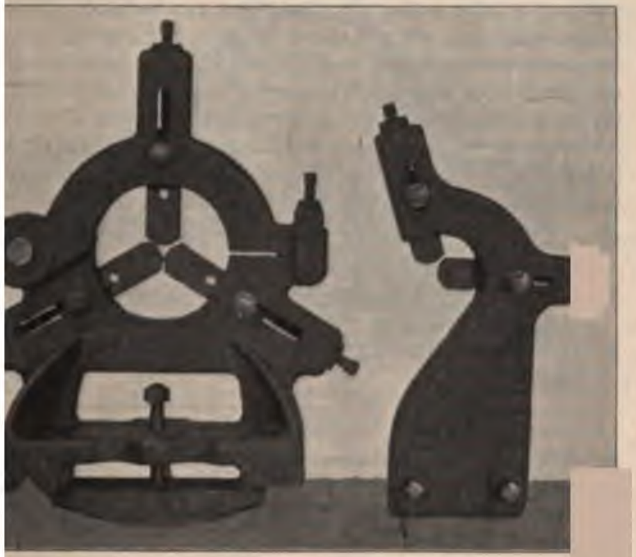
# ACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—6.

## TURNING LONG WORK AND OFFSET TURNING.

W H. VAN DERVOORT.

article No. 3 the method for turning a plain spindle held een centers was taken up somewhat in detail. When the lle is very long and its diameter relatively small, it be- s necessary to support it at some intermediate point or to de some form of support immediately back of the cutting as otherwise it would, owing to its own weight and the ure against the cut, spring excessively causing it to chatter eave an untrue surface. In such a case, the cut would have very light to prevent the work from bending or climbing o the point of the tool, which is a very exasperating acci- that frequently happens even when the greatest care is ised, and it usually results in spoiling the work.

e center or steady rest in its general form is shown in Fig. Its construction is plainly seen from the figure. The foot mped to the shears of the lathe at any convenient point and hree sliding jaws are so secured that they can be adjusted a portion of the work's length that has previously been d true and smooth. If the bar is to be turned over its entire h, this spot is usually taken just off the middle point and e closer to the live center than the dead one. This enables perator to turn from the dead center toward and some- past the middle. The work can then be reversed, the jaws ted to the turned portion and the balance of the spindle ined. Truing the spot is usually slow, as light cuts must ken in order to get a round section that is concentric he axis of rotation. It is also difficult to properly set the of the center rest upon the spot without throwing the center out of the line between the centers of the lathe. It ally best to adjust the two bottom jaws first and thus the work of the deflection due to its own weight. The if set too tight upon the work, will heat and score it. ould always be used and the ends of the jaws kept in good tion. If the work is to be machined only at points on gth, then the center rest should be set as near as possible point where the work is being done, and thus give the st amount of rigidity.



FIGS. 51 AND 53. CENTER-REST AND FOLLOW-REST.

quently it becomes necessary to steady a bar for turning not and cannot be made round at the point where the rest is to be applied. In such cases the device shown . 52 and commonly known as a cat head may be used. It is a collar turned round on its outer surface and provided uitable set screws for centering it up on the work. This a round bearing which, as before, is made to run within the of the center rest. The cat head must be so adjusted that s perfectly true on the outside or otherwise the work ot run true when the head is removed after turning. The of crowding the work with one of the jaws out of its xis of rotation is to turn the work tapering. Thus, if the work is crowded by the center rest toward the tool, it will be turned smaller in the center than at the ends and in like manner larger at the center if crowded away from the tool. Vertical motion does not affect the diameter to so great an extent, since, if the tool is set at the height of the center, the work can be raised or depressed quite a distance without making much change in the diameter. If, however, the tool sets above or below the center, a material taper will be given to the work. For example, if the tool sets above the center and the work is depressed at the center rest, it will be turned larger in diameter at the rest than at the dead center. Very often it is desirable to support the work right at the tool for the entire length of the cut. This is accomplished by using the follow rest, an example of which is shown in Fig. 53. It is quite similar in its most general form to the center rest, having two jaws, one behind and the other on top of the work. It is secured direct to the carriage and consequently moves with the tool. If the work is in the rough, the rest follows after the tool, but if it has been previously trued, the rest may be set ahead of the tool. It is, however, usually preferable to have the rest follow rather than lead the cutting tool. For work of small diameter a single jaw with a V-end serves well.

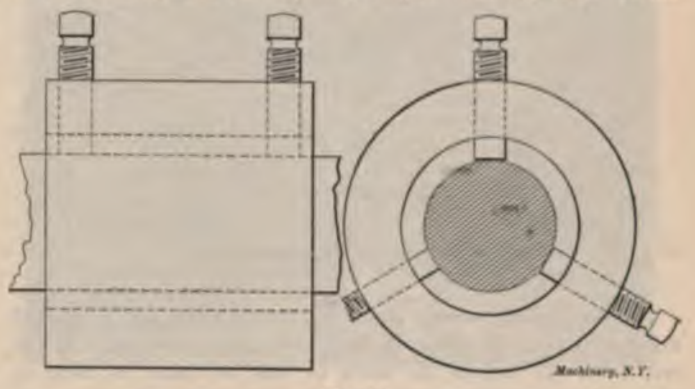


Fig. 52

The producing of satisfactory results in the use of the follow rest requires good judgment on the part of the operator. It should be set as soon as possible after the cut has left the dead center and while the work is rigid and true. Any irregularities in the work surface on which the follow rest passes serve to reproduce these same irregularities throughout the length of the work, and it is, therefore, very important to start exactly right. In the cutting of threads on long light rods the follow rest is indispensable. It is also of value in steadying work that is being operated upon by a cutting-off tool. It is superior to the center rest for this purpose, inasmuch as it can be set so much closer to the point where the cut is being taken.

An example of center rest work is shown in Fig. 54. Here, as is frequently the case, it is required to operate on the end of the work which precludes the possibility of running that end on the center. The center rest carries the outer end, the tail stock is moved back out of the way and the carriage is given ample room to get the tool at the work surface. The work must be firmly secured to the head spindle. When a center bearing can be had in that end of the work, it is best to carry it on the live center. This requires some method for clamping it to the face plate to prevent it from drawing off the center. When the work has a convenient shoulder near the outer end, the inner faces of the jaws of the center rest may be made to bear against the shoulder and thus prevent the work from drawing away from the live center. A collar can be clamped on the work to accomplish this result, but this method is not satisfactory except, perhaps, in the case of very light work, as the center rest is not rigid against a side pressure and the cramp of the dog or driver is quite certain to crowd the work off the center. A clamp, as shown in Fig. 55, slipped over the work behind the dog and drawn, by means of the bolts, firmly against the face plate will be found quite satisfactory. It is necessary that the clamp be drawn up squarely, as otherwise the truth of the work, especially if light, will be effected.

In cases where there is no center bearing in the live center end of the work, and one cannot conveniently be arranged for, that end can be carried in a chuck. If the chuck is an independent one, the work must be very carefully centered in it. If a universal chuck is used and exact centering of the work is required, it is equally necessary to test the truth of the work, as universal chucks, after being somewhat worn, lose their accuracy for exact centering. The work should be caught close to the ends of the jaws, except in cases where the jaws and surface of the work gripped are known to be absolutely true; otherwise the outer end of the work will be thrown out of the center of rotation and, if brought back by the center rest, a spring in the length of the work must result. It is, in any case, difficult to set the center rest so that it will hold the axis of the work exactly coincident with the line of the centers. If not so held, the work will run true but all cuts will be tapering. If it is much out in this adjustment, it will cause the live center end of the piece being machined to work on the centers or in the chuck jaws, the usual result being the loss of the grip. The stiffer the work, the more noticeable this action.

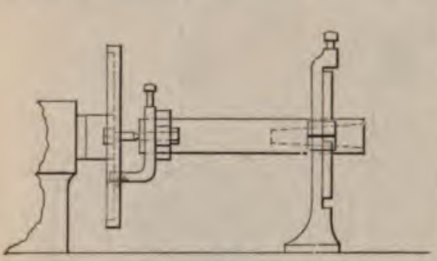


Fig. 54

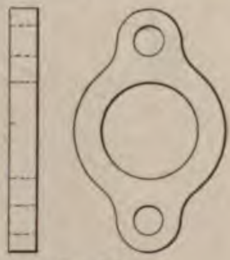


Fig. 55

The turning of external tapers can be accomplished in several different ways. As above indicated, in center rest work if the rest holds the end of the work so that its center is back or ahead of the line of centers, tapered work results. In like manner where the work is carried on both centers, if the dead center is moved across the bed, the center line of the work will be at an angle with the direction of motion of the carriage and tool, and tapered work results. As all engine lathes are provided with a set-over adjustment in the tail stock, this method of turning tapers is always available. As the amount of side adjustment is limited to a small range, only slight tapers can be produced in this manner, and especially so in cases where the work is long. Thus, if the tail center can be set over one inch and the work is four feet long, then, as shown in Fig. 56, it will be turned two inches smaller at the dead center end than at the live center end, which would give a taper of one-half inch per foot. If the work was one foot long, as shown by the dotted lines, it would have a taper of two inches per foot. The above indicates the method for determining the amount to set the tail center over to produce any taper per foot within the limits of the adjustment. Thus, if the work is eighteen inches long and a taper of five-eights of an inch per foot is required, at one foot the off-set would be one-half the required taper or five-sixteenths of an inch, and at one and one-half feet it would be 1½ x 5-16, or 15-32 of an inch. This is, of course, only an approximate method for determining the proper amount of set-over as the exact amount must, in nearly every case, be found by trial. It will, however, serve better than a guess for the first trial. The principal objection to this method of taper turning is that the centers of the lathe no longer point toward each other, and the center bearings in the work do not, therefore, bear properly upon them. This frequently causes excessive wear on the bearings and sometimes throws the work out of true. The ends of the work must be faced off perfectly square or otherwise the work will be sure to run somewhat out when held on off-set centers. Since in this class of turning, the work does not stand at right angles to the face plate, it is necessary to allow for some in-and-out motion for the arm of the dog or driver through the face plate. When the lathe is provided with a taper attachment, as shown in Fig. 8, article 1, external tapers may be turned without off-setting the dead center. This leaves the true bearings on the centers and does not necessitate the difficulty of having to adjust the dead center for parallel turning each time a taper job has been done. Taper attachments are given a much wider range than can be obtained by offsetting the center and are equally as useful in boring tapered holes or in turning external tapers.

In all taper attachments the mechanism is such as to operate the tool rest direct from a guide set at any required angle within its limits, with the shears of the lathe and independent of the cross-feed screw, yet at the same time retaining the in-and-out adjustment of the cross-feed screw. As several parts and consequent joints are required in such combinations, a considerable amount of back lash usually exists. The effect of this back lash is to let the tool start on a parallel cut until the back lash is taken up when it starts off on the required taper. This, although annoying, can usually be overcome by carrying the tool enough beyond the end of the work to allow the slack to take up by the time the tool is brought up to the cut. It will be understood that it is not necessary to let the feed bring the tool up to the cut, as it can be advanced quickly by hand, the only point being to carry it far enough to take up the slack by the time the tool reaches the work. On work of small diameter where the tool strikes the side of the center if moved beyond the end of the work, the back lash can generally be taken up by pulling out or pushing sharply in on the tool post, depending on the direction of taper the attachment is set to turn. Thus, if it is set to turn an increasing taper from the dead center toward the live, the angle of the guide will be such that its end nearest the head stock will be the closest to the shears and the inside face of the block will be forcing the tool back from the center of rotation. It would then be necessary in taking up the back lash at the beginning of the cut to push the tool toward the center. The maximum range usually given the taper attachment is four inches per foot.

It is seldom necessary to turn or bore steeper tapers than can be bored with the taper attachment. When, however, such are required, a lathe with a compound rest can be used. Examples of the compound rest are shown in Figs. 3, 8 and 10, Article 1. Its construction is such as to allow the upper slide which carries the tool to be set and secured at any angular position with the cross slide, thus enabling the turning or boring of any taper. Although the range is small, steep tapers are usually short and it is consequently seldom that the tool must be reset in turning any ordinary taper. What is commonly known as offset turning between centers is illustrated by the example shown in Fig. 57. In this case it is required to turn the pin of the crank shaft. The shaft proper having been turned or preferably roughed down nearly to size, the off-sets are placed on its ends as shown. The centers, H H, in the off-sets are at a distance from the center of the shaft equal to one-half of the required throw of the crank. By means of a surface gauge and of a plane table upon which the crank rests, the centers of the shaft, the off-set centers and the center of the crank pin are brought into the same plane. By now placing the shaft on the off-set centers, the center of the crank pin falls in the center of rotation, and by means of a long tool that will reach the pin through the throat of the crank, it is readily turned. A sufficient counter weight should be placed on the face plate opposite the shaft to balance it and thus make the lathe rotation smooth. As it is not possible to use a center rest on work of this kind, and as danger of

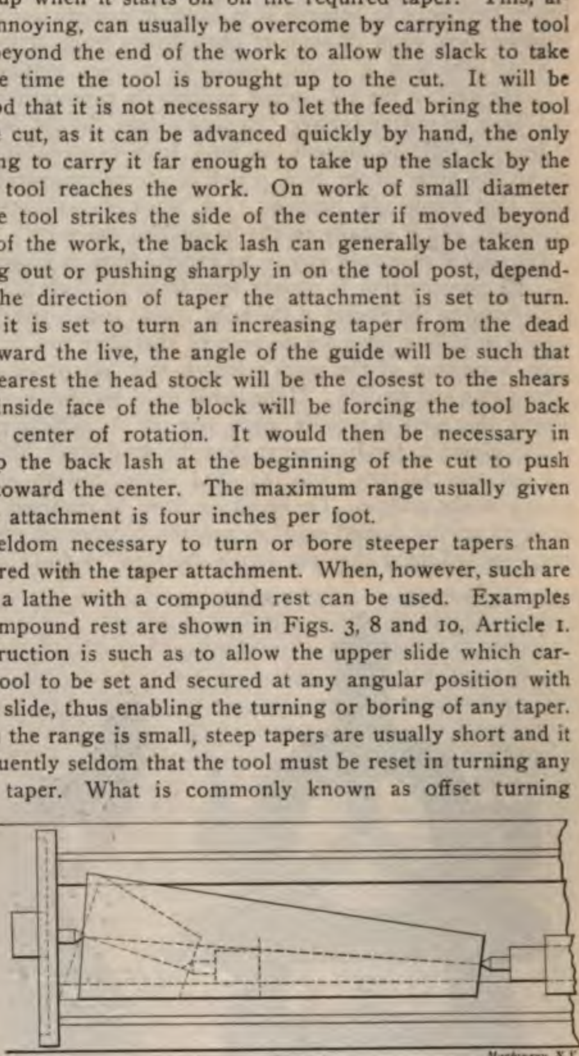


Fig. 56

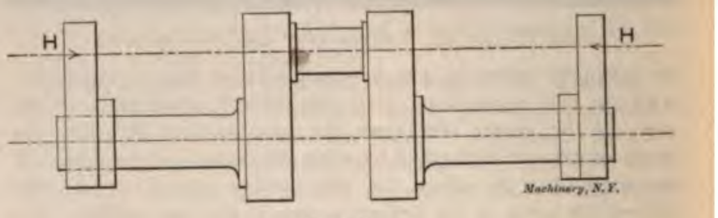


Fig. 57

springing the shaft is great, considerable care must be exercised in turning the pin. In turning the shaft, a center rest can be used. It is usual to place a block firmly in the throat opposite the ends of the shaft to prevent springing the arms together. The finishing cut should be a light one taken with the block removed and the centers very lightly adjusted, thus insuring a true running shaft when complete. Eccentric turning comes under exactly the same head. The center of the eccentric, however, usually comes inside the bore and the off-set centers can therefore be placed in the mandrel itself.

* * *

An employe of the Pennsylvania Railroad is reported to have invented a mechanical stoker for locomotives which is destined to "displace several hundred thousand firemen and allow locomotives to be run by one man instead of two." It is stated that "by merely turning a little wheel an engineer can feed coal into the firebox at the rate of 21 cubic feet per second." With the gradually increasing size of locomotives, it is probable that either mechanical stokers or two firemen instead of one will be the rule, but railroad companies will have to furnish free accident policies to their patrons if they expect them to ride behind locomotives having a crew of only one, as this inventor would lead us to expect.

* * *

Machinery New York

### CHAPTER 5.—A COMEDY OF ERRORS.

Jones always had a lot of boys around his shop, not that he was fond of boy help, but he found it difficult in the country to get men to do boy's work. "The great army of the unemployed" has its camp in every large city, but not even a picket line stretches out to Jonesboro. Now these lads were about as playful as a cage full of monkeys and Jones was often bothered to keep them in check. One morning, among the misfortunes which never come singly, was a broken belt, and Jones roared and bellowed for those boys, like an old-time sea captain. "Here, you Dick, and you Charley, lay aloft there and lace that belt, and be spry about it, too." Jones' idea of economy was to buy a side of leather and cut off a strip for a lacing whenever it was needed, and those kids carved that hide into all sorts of fantastic shapes in getting out enough leather to lace one small belt. Then they played "hollowe'en," throwing the lacings over their heads to see if they would take on the shape of any letters when they struck the floor. They played they were firemen, turning out to a fire and they put a ladder up and both ran up the ladder with the agility of monkeys. In this manner the lacing was accomplished and the job was reported done. The "old man" was not at all pleased with it, however. "Here, you, haven't I told you whenever you laced a belt to keep the lacing straight on the inside and cross on the outside of the belt? Now, I've got to take that all out and lace it over again and I want you to see how I do it. Hold that ladder for me." Still grumbling away he mounted the ladder and slowly picked out the offending lacing and laced it over as a "sampler" for the boys. Then he climbed down and directed them to pick up the tools and put away the ladder, but the ladder could not be removed. Jones had laced it in! The boys exchanged nods and winks, which Jones happened to see. "You, Dick, what are you winking about?"

"Wasn't winking, sir; my face slipped."

"Well, see that it doesn't happen again. It's a good deal as the poet says:

'One boy is a boy,
Two boys half a boy,
Three boys no boy at all.'"

What did Jones say about the belt? Well, what could he say? He was spared the necessity of saying anything, for just then in walked a man with his arms full of patterns and his pockets bulging with drawings, and the "old man" was only too glad to entertain him. He wanted a machine built, but, as he asked Jones to keep the nature of it a secret, I will not betray his privacy; however, I will tell you some of the incidents of his visit. He prided himself on the excellent proportions of his design, and asked Jones if he had ever done anything in that line.

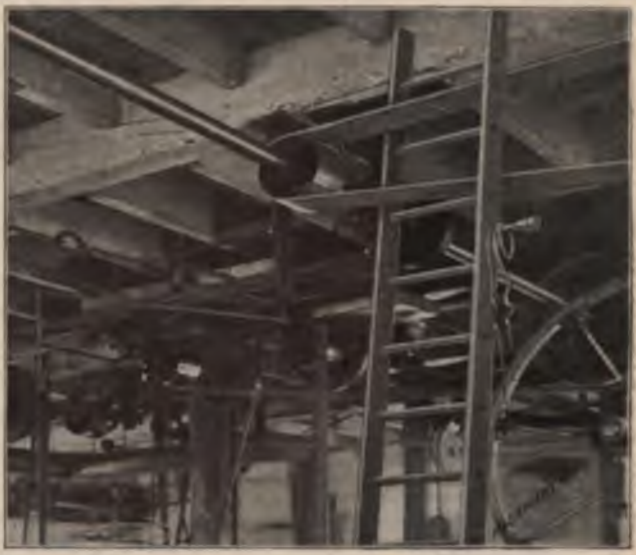


FIG. 1. A SAMPLE OF BELT LACING.

"No," said Jones, "hain't got no proportional dividers."

"Proportional dividers?" asked the stranger.

"Yes," Jones answered. "Them kind that you can set to any sort of a machine that you happen to be getting up and get the proportions of the different parts. Don't have to do no guess work at all, if you are getting up a lathe; jest set them for a lathe and they'll give ye the right proportions of the spindle and the bed and the legs, at least that's the way I understand it."

Machinery, N. Y.

FIG. 2. "HIS NAME WAS MAC HINERY."

"Ah, indeed! Must be a great convenience," said the stranger "Now I get most of my ideas of proportion from this," opening a copy of MACHINERY.

"Looks like a good thing," Jones replied. "Do they get a new one each year?"

"Every month," said the stranger, and reaching for a piece of paper he jotted down the name and address of the periodical and handed it to Jones. His machine proved to be easily understood excepting one point. He had detailed a sort of lifting jack which was designed to raise the point C 1¾ inches, as illustrated in Fig. 3. Jones understood the movement well enough, but he argued that, as the short arm A of the bell-crank was only 1½ inches long and moved from a horizontal to an upright position or through 90 degrees, the lift could only be equal to the length of this throw, or 1½ inches, and he could not understand where the additional one-quarter inch was gained.

"The link B," said the inventor, "is the hypothenuse of the triangle when in its normal position, and is one-quarter of an inch longer than the altitude."

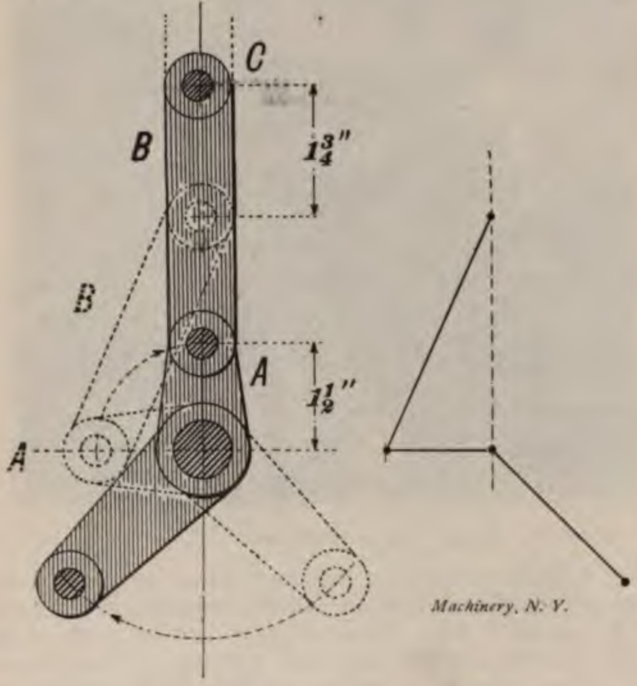


FIG. 3. THE "HIPPOTIMUSE."

"Don't know nothing about hippotimusė. All I know is, we'll build yer jimcrack jest accordin' to yer draft, and if it lifts an inch and three-quarters, well and good, and if it don't lift but an inch and a half, don't say I didn't give yer fair warnin'."

"Very well, Mr. Jones, if you work according to my drawing that's all I ask. Good day."

"Dad, who was that?" asked young Jones.

"He give me his address right here," said the old man, looking at the slip of paper which his visitor left. "His name is MACHINERY, 9 to 15 Murray street, New York."

"Less see that paper. Why, dad, that ain't his name; that's the address of that paper he was a showin' you."

"Gosh! so 'tis, sonny." W. H. S.

* * *

## BALL BEARING REQUIREMENTS.

In considering the general question of requirements for a ball bearing that is to sustain such a load as is commonly met with in machines, we find that we must have balls of uniform size and each of uniform diameter; something which is now attained to within $\frac{1}{10000}$ of an inch. To insure rolling contact without rubbing of balls, and to distribute wear, it is often necessary to confine the balls in cages. To avoid slipping, a bearing surface of the same radius of curvature as the ball cannot be used. The bearing surface on which the balls roll should be hardened and ground to perfect truth. Large enough balls and a large enough number of balls should be used to carry the load without danger of breaking.

This last qualification looks to be easy of attainment, but is really an uncertain factor in the design, for two balls apparently exactly alike, as far as making is concerned, will vary considerably in strength. As the failure of one ball will generally ruin the entire bearing, uniformity of strength is therefore a requisite.

If, as the tests indicate, the average breaking load for a one-inch ball be about 80,000 pounds, and these balls will flatten at about 7,500 pounds pressure, the rule of loading balls to one-fifth of their breaking capacity is far from being even approximate. If held directly between two parallel surfaces less than a tenth of their breaking load would be a nearer approximate for safety and durability. If, however, the ball rolled in V grooves so as to have four points of contact, then a higher load could be carried safely. The surface resistance of a small ball of ¼ or ½ inch diameter is probably as great as that of an inch ball, in which case it might safely carry the same load as the large one if this were within its elastic limit. This matter should be carefully investigated, but from what is already known it would seem that the safe load for a ball should not be based on its breaking load, but on that load within its elastic limit which will mark its surface when in contact with a hardened flat plate, as described above.—Alton L. Smith, in "Journal of Worcester Polytechnic Institute."

* * *

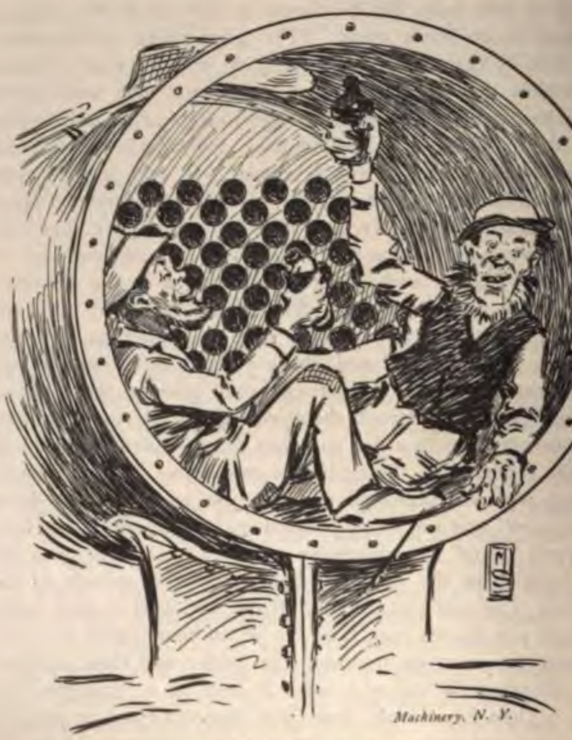
## WORTH HEEDING.

At the annual meeting of the National Railroad Master Blacksmiths' Association words of wisdom were spoken that will bear repeating. In the course of an address Mr. J. M. Barr said: "I always have trouble when I want to pick out a man to take charge of other men. I do not know where I can find a man that will fill the bill. I think that men in charge of work ought always to look for the man that shows some ability and give him an opportunity to show what he can do. Give him a 'shove.' I do not care whether he is in your shops or not; if you have a good man help him when you can. Do not, because you have a good man, hold him there at small pay, but give him a position in some good shop and he will be ready to come back to you when you want him."

Mr. R. Quayle, superintendent of the M. P. C. & N. W. Ry., said: "The point I want to make is that men you have about you are intelligent and thoughtful; they know a good thing when they see it and they appreciate a good foreman when they have one, and are not nearly so much inclined to take advantage of a foreman who treats them kindly when he is absent as they are the man who is harsh and abusive and stands over them with a club. The old homely saying that you can catch more flies with molasses than with vinegar is also true with men. If you want the best out of me don't abuse me, but appeal to me as a man, and if it is in me I will measure up to your requirements. Is not the same thing true of you, and if it is true of you is it not true of any man in your employ? This is one of the various means for getting the largest possible returns for money expended."

* * *

## SHOP TERMS ILLUSTRATED.


Machinery, N. Y.

BOILER JOINT.

# LETTERS UPON PRACTICAL SUBJECTS.

## TESTING ENGINE LATHES.

*Editor* MACHINERY:

In my article on the testing and adjusting of engines lathes, which appeared in the October number of MACHINERY, it was not intended to go into the many methods used for this purpose, but simply to give a few of the most simple examples. It was also intended to take up each alignment separately. This latter point, "Nemo," in his criticism in the November issue, evidently lost sight of, since in testing the carriage cross-shears for right angles to the spindle it was assumed that, as by the preceding paragraph, the spindle was parallel with the shears on the bed.

If after facing the plate, it should be plane when tested with the straight edge, the spindle and cross-shear must be at right angles with each other as stated. If it does not bore a straight hole an entirely different alignment must be considered, as we would find the rather unusual condition of spindle not parallel with shear and cross-shear out by exactly the same angular amount.

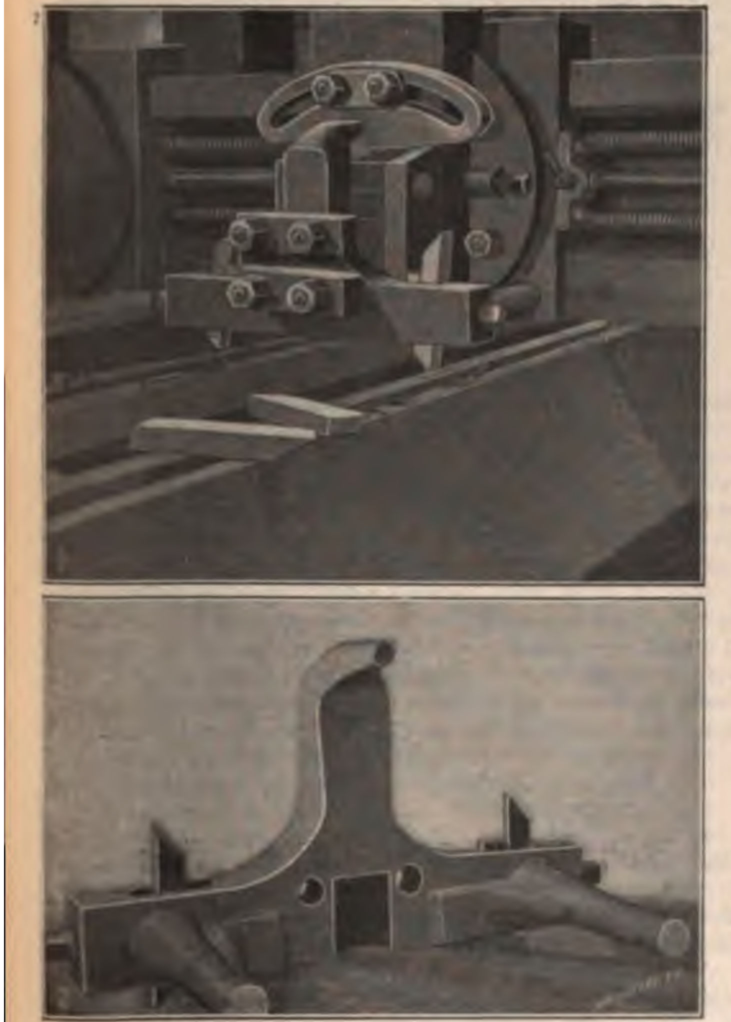
W. H VAN DERVOORT.

* * *

## TOOL HOLDER FOR PLANER.

*Editor* MACHINERY:

The tool shown in the accompanying half-tones, Figs. 1 and 2, and sketch, Fig. 3, is a duplex roughing tool holder, designed principally for roughing off the top and shears of lathe beds. It is designed to be used only where the heads on the cross-rail cannot be brought close enough together. The tool consists of a cast iron head with two arms, one on each side extending out about 8", two legs at the extreme end of each arm which extend back and bear on the planer saddle. This forms a very rigid support for the tools. The head is clamped on the tool box in the same way as on any other tool, only the two lower studs come through the head. The nose at the top of the tool extends back within a ¼" of the apron swing, acting as a stop.



FIGS. 1 AND 2. TOOL HOLDER FOR PLANER.

As the planer reverses, the apron cannot rise too high and cause the tools to catch or bind, as the nose or stop will prevent the apron from rising above a certain point.

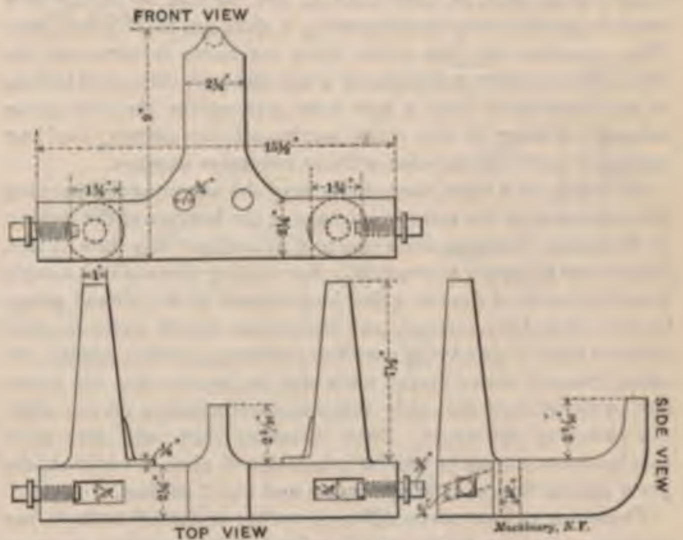


FIG 3 DETAILS OF HOLDER.

There are two slots, one in each end of the arms, ¾" wide by 2" long. These are to receive ¾" square self-hardening steel. The slots are made 2" in length, so that the tools can be adjusted for different size lathe beds, by placing a gib on either side of the tools. The tools are held in position by two ⅜" screws, one at each end of the arms. There are two pads, one on each side of the apron. When the apron is down these pads bear on the tool box, while the legs bear on the saddle. The results obtained from the use of this tool are very satisfactory, and it can be used single or double and will stand a good heavy cut.

HENRY J. NOTZ.

Hamilton, Ohio.

* * *

## INSERTED CUTTER LATHE TOOLS.

*Editor* MACHINERY:

It has been many years since inserted cutter tools were invented to take the place of tools forged to shape, but for some reason they are not used as much as their merits seem to justify. During all this time these cutter tools have been in the market and available to users, but although I have worked in many shops and visited many others, I have never seen any such tools in practical use, except a few home-made affairs, mainly of poor design or construction. I have sometimes discovered such tools on the tool board, but always without any cutters, and I doubt if any of them had been supplied with a second cutter after the first one was used up.

The old-time forged tool has two features which may never be equaled by any cutter tool. First, it is stronger, more rigid and can be used in a smaller space than is possible with the cutter tool. Second, it will conduct the heat away from the cutting edge more effectively. If heavy and rapid cutting is to be done, or if the tool must work in a limited space, it is unpractical to use the inserted tool. Much the greater part of the work done by machine tools, however, is finishing and shaping surfaces that have but a limited amount of stock to be removed, and for this work the cutter tool is superior in several ways.

The systematic method, developed by Sellers, of making standard forged tools is, of course, the right way to make them if enough are used to justify the high cost of grinding machinery, but that is certain to prevent the use of the system in a large majority of shops. In medium size and smaller shops and particularly in job and repair shops, the cutter tools are the most useful and certainly deserve a fair trial.

The value of forged tools depends much on the skill of the tool dresser and few such shops have blacksmiths who are good tool makers. Forged tools have so much surface to grind when sharpening, that to save time they are often badly ground and hence are inefficient. The cutter tools usually have either the rake or the clearance fixed by the position of the cutter, so that the sharpening is done by grinding all on one or two faces, which is a saving of time and steel, besides making it much easier to keep the tool the right shape. There is also an advantage in having cutters of uniform temper throughout, produced by an expert, who, perhaps, does nothing else, so that no matter how much is ground away in sharpening, it does not reach a soft part. Then consider the time saved when the cutter is worn out, by being able to insert a new one in a few minutes, instead of loafing in the blacksmith shop a half hour waiting for the tool to be dressed. Owing to the small section of the cutters, the best quality of steel may be used without excessive expense.

For using on a lathe, these tools have the advantage of keeping the cutting edge the same height above the bottom of the holder, so that when changing from one tool to another very little, if any, adjustment of height is required. For cutting threads it is simply a foolish waste of time to grind forged tools to fit a thread gauge by the cut-and-try method, and such tools should never be used unless a special grinder is used for producing correct angles, because inserted cutter thread tools may be bought that are excellent in design and are easily sharpened by grinding on top without changing the angle. Such threading tools will save their cost by the economy of time in grinding and give, in addition, the great satisfaction of doing accurate and rapid cutting.

There are at least seven different makes of cut-off tools in the market and about as many other kinds, and certainly some of them must be in extended use, for they have been in the market for a number of years.

About all the advantages seem to be in favor of the inserted cutter tools, especially for small shops, and I would like to know why they are not in more general use.

If they have serious faults, will some of the people who have used them come forward and tell us just what is wrong with them and give, if possible, the reason why more of them are not in use? I do not remember ever having seen a record of any experience or opinions about such tools in the mechanical papers, but if they are a good thing I do not see why they should not be discussed and their merits made more familiar to machinists, for I am sure cutting tools are of a great deal more importance than many of the subjects that fill the pages of mechanical papers every year.

If there is no response to this I will take it for granted that such tools are faultless and that there is therefore no excuse for any shop to be without a suitable supply of them.

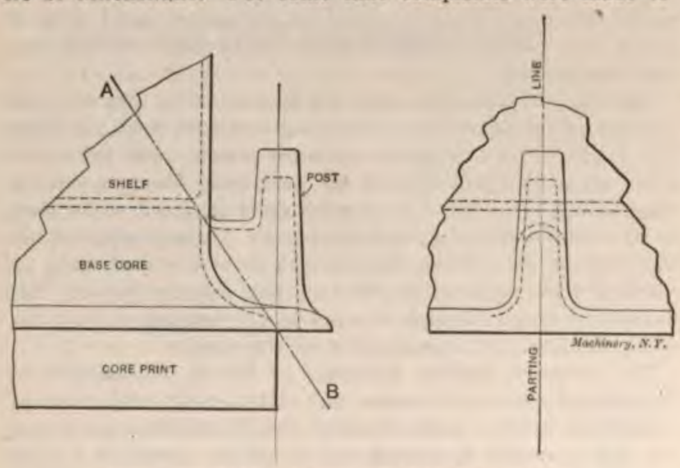
BELL CRANK.

* * *

## HOW AN OBJECTIONABLE FIN IS PREVENTED IN A LARGE CASTING.

*Editor* MACHINERY:

The following experience may prove of interest to some readers of MACHINERY. For some time complaints were made to the foundry foreman that a fin in one of the large castings made for the shop caused much trouble. It was necessary to chip and break the fin so that a shaft could pass through the hole without interference. This chipping was no light task. The complaint was offered from time to time, but as no remedy was applied except a little more care in moulding, the fin continued to appear more or less with each casting. I was inspecting the patterns one day when the man in charge of the floor called me down (so to speak), giving me to understand that I was to have the pattern fixed, or do something to prevent the fin. Well, I was a little surprised. yet had to admit that the fin was surely objectionable and ought to be removed. I did not know that I had anything to do but to see that the pattern measured all right.



SKETCH SHOWING METHOD OF ARRANGING CORES.

The cause of the fin can be easily explained by referring to the sketch. You will notice that the post is near the base so that it can be cored with the base and is also on the parting line. The base cores are in halves and are anchored to the flask.

It was only natural that the moulder should not want the projecting post part of the cores to come together when he closed his flask before the body of the cores met; if they did, the post part was in danger of breaking. So he filed a liberal clearance at the post part giving, as can be seen, a fin of varying thickness when the casting was made.

Thinking over the matter, I saw there was no good place to support an independent core without some trouble in setting. Then an idea came to me: Why not cut off the post part of one core just at the body before baking, then, after baking, paste this piece to the other half of the core, making the post part solid?

I spoke to the core-maker about the scheme and he approved of my suggestion. He cut one core as indicated by the line A—B, and after baking pasted it to the other half core. We made the cut wide enough to prevent interference of cores when the flasks were put together. This gave a fin on the line A—B, but no harm could come of it there.

When I told the man in charge that there would be no more fins in that part of the casting his pleased look and remark: "That is the way it should be," made me feel that I should like to have him mention some other trouble for me to remedy.

Providence, R. I. EDWIN C. THURSTON.

* * *

## A NOVEL LATHE TESTING MACHINE.

*Editor* MACHINERY:

Two subjects treated in your November issue, "Turning Crank Shafts" and "Testing Engine Lathes," brought a smile to my face at the recollection of an incident which I will relate. Some years ago I had occasion to turn crank shafts for gas engines and, to facilitate the work, I hit upon the precise method described by Mr. De Sanno. The most marked immediate result of my plan was that my most capable lathe man refused point blank to turn a crank shaft in that way. When I insisted, he picked up his tools and left me, saying: "I have turned hundreds of crank shafts and I guess I know how to turn them."

My scheme for testing an engine lathe may not be adopted generally as a "survival of the fittest," but it served its purpose and the work was quickly done. I had need to raise the headstock of an 18" lathe, to swing a piece too large for its normal capacity and to bore therein a somewhat deep hole, which needed to be true to size throughout its whole depth. To align the head to the ways, I took a piece of pine about 1"x2"x24" and caught one end of it in a chuck, fastening it firmly. I then took an ordinary "star candle," cut from it four pieces, each one about 1 inch long, and fastened two of the pieces with their own grease to the pine bar near the chuck so that they were opposite each other. The other two were fastened at the farther end of the bar. The axes of the pieces of candle were all radial to the center line of the bar. Now by using a keen cutting tool, I could turn the substance of the candle smoothly without any perceptible spring of the bar and thus, by careful calipering, determine when the headstock was brought to and clamped in perfect alignment with the lathe bed. The wicks, of course, were removed from the candle ends used. C. C. HILL.

Chicago, Ill.

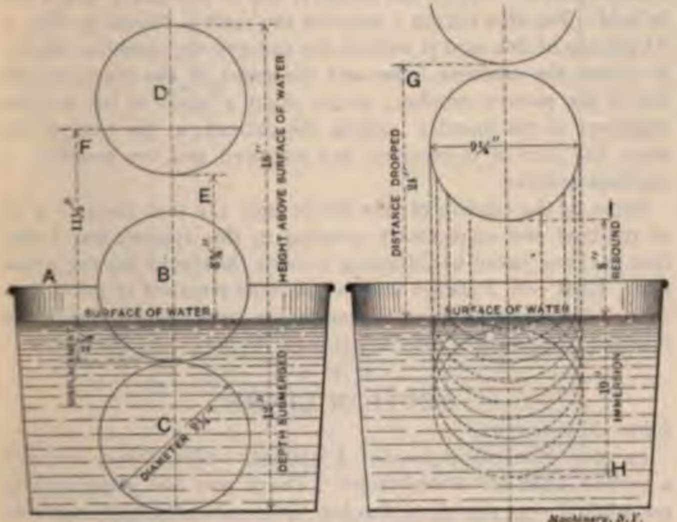
[It appears that this method of testing lathes is one that can be easily tried, and under proper conditions ought to give quite reliable results. Thus, a stick of pine wood, two or three feet long, and turned to a diameter that would leave a stiff and light bar, could be coated over with wax of a consistency that would allow turning with a minimum resistance to the tool, but still be firm enough for calipering. Such a test would be chiefly valuable for adjusting a lathe to bore accurately.—Editor.]

## A PHENOMENON THAT APPEARS TO CONTRAVENE KNOWN LAWS.

*Editor* MACHINERY:

This phenomenon, which appears to be at variance with the known laws of nature, consists of the action of a hollow metal vessel of a peculiar shape, hermetically sealed, which, when submerged and released, will rise to the surface of the water with such velocity as to go beyond the usual limits of a floating body. It will rise in the air above the surface of the water. The movement of this body in ascending to the surface is opposite to that upon which the well-known law of retarded velocity is based. Instead of having a uniformly retarded velocity in rising, it has an accelerated velocity, induced by the pressure of the water upon its peculiar lines, independent of the buoyant energy. In ascending to the surface there is very little disturbance and it flies into the air as if released from a metal spring. When dropped into the water it rebounds into the air.

In drawing this vessel along on the surface of water mixed with meal, there is very little commotion among the particles of meal held in solution. They pass under and around and come back to their original position in the wake. Apparently, there is no dead water. In extending the lines of this object, they resemble somewhat the underbody of the modern racing machine.



ILLUSTRATING A PECULIAR PHENOMENON.

The results of several experiments are shown in the annexed diagrams. A is the tank containing water; B is the float at rest on the surface of the water, showing line of flotation and displacement; C shows the float submerged twelve inches below the surface; D shows the height above the surface of the water it will ascend after releasing; E shows the height from surface to bottom of float in the air; F shows the height above water of the line of flotation of the body in the air.

In the second diagram, G shows the distance the object is dropped to the surface; H shows the depth of immersion; I shows the distance it will rebound into the air. From the performance of this vessel through and on the surface of water, there is a remote possibility of its containing that which is much sought by yacht builders, the lines of least resistance.

Who will offer an explanation of this peculiar action?

Norfolk Navy Yard. GEO. C. STANLEY.

* * *

## A PRACTICAL PROBLEM IN THREAD CUTTING.

*Editor* MACHINERY:

I have a problem in cutting a worm for a small engine which is being built in our shop and would like to have it shown up so that the readers of MACHINERY may answer it if possible.

The worm required is octuple, being one thread to the inch pitch and eight threads around the circle of a 5/16" rod. A large gear could not be used on the stud of our lathe and no provision has been made in its construction for compound gearing. In consequence, we cut a double gear like the one shown in Fig. 1, in which the large gear has 128 teeth and the small one 32 teeth. The hole through this gear was made to fit the intermediate stud of the lathe. Then by putting a 64-tooth gear on the stud, so that it would mesh with a 32T special gear and having a 32T gear on the lead-screw meshing with the 128T gear we obtained a ratio of 8 to 1 between the lead screw and the stud. The lead screw of the lathe has eight threads per inch, so with this combination we had the lathe rigged to cut a 1 inch pitch screw. The arrangement of the gearing is shown in Fig. 2, which shows the 64T and 37T gears on the stud, the 22T and 20T tumbler gears in the headstock and the two 37T gears on the stud and spindle. All the other gears are outside the headstock, being one 64T gear with a 32T gear and a 128T gear with a 32T gear.

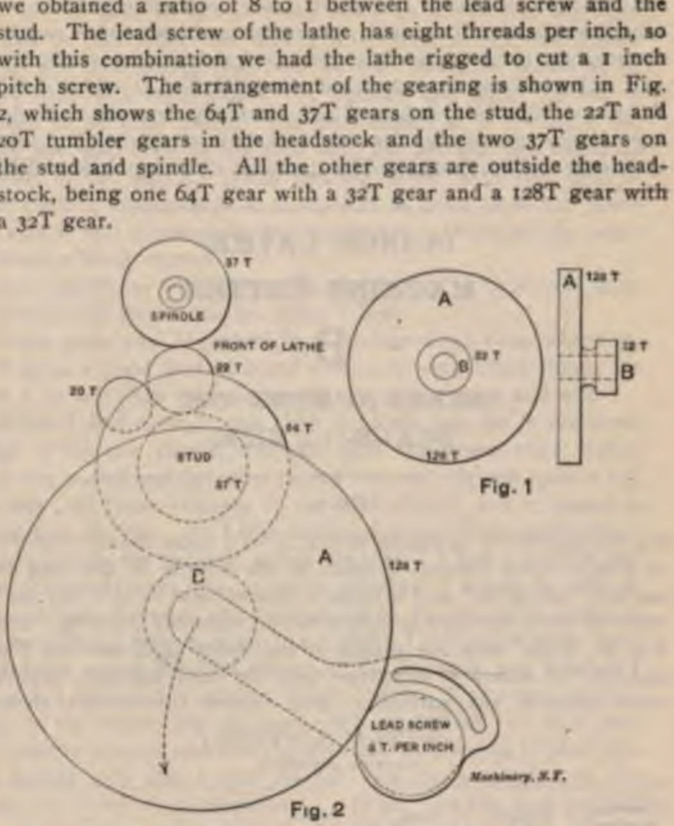


Fig. 1

Fig. 2

ARRANGEMENT OF GEARING FOR SCREW CUTTING

With this arrangement of gearing, I cut a thread and ran the carriage back to the starting point and after pulling the belt down towards me to take up all lost motion, I loosened the nut which holds the special gear up to the 64T gear and the arm holding the special gear dropped down till it cleared the 64T gear on the stud. Then I turned the lead-screw through one revolution and put back the intermediate 128-32T gear in place, cut another thread and so on. I found that I could cut eight parallel right hand threads very well that way, but the "boss" requested me to cut a left-handed thread of the same pitch and the same number of threads and here I met the "sticker." I proceeded as before, only changing the lever in the headstock so that the 20T gear was driven by the 37T gear, the 22T gear by the 20T gear and the 37T gear on the stud by the 20T tumbler gear. I took up all the lost motion, ran the carriage back to starting point, turned the lead screw once around and cut the thread. When I got through I had nine parallel threads instead of eight as before.

Can you explain why I got one more thread left-handed, and why if the lathe cuts right and left-hand worms the same pitch with the same gears, I obtained one more thread under these circumstances. I send you a sample piece of brass having right and left worms cut to show you the eight and nine parallel threads. I am very anxious to get at the bottom of the difficulty and hope for satisfactory solution.

Poughkeepsie, N. Y. EDWARD O. JOHNSON.

* * *

## NUMBERING PATTERNS AND DRAWINGS.

*Editor* MACHINERY:

Here is a system for numbering patterns and drawings which has proved very successful, and to illustrate it I will use the drawings and patterns of a 14" lathe. When a machine is designed it is given what is termed a machine letter. In the right hand corner of every sheet of drawings will be found the name of the machine, the machine letter, the sheet number and the scale size, as shown in Fig. 1, of the accompanying sketches. These sheets are filed in cases containing drawers, each drawer being numbered by a letter. The drawings having been placed on file, the question arises how can any particular sheet be found without beginning at the top and looking through each drawer? This obstacle is overcome by adopting the card shown in Fig. 2. In the center of this card, at the top, are written the name of the machine and the machine letter; at the left of the card, the number of the sheet of drawings; in the next space to the right which drawer the sheet is in; next, which case contains the drawing in question; after that, and lastly what part of the machine is contained on a sheet of drawings of any number.

It will be noted that the card shown in Fig. 2 is for detail drawings only. A number of our machines, however, are designed with an assembly drawing, and these are placed in a separate case and are designated by the name of the machine and by the machine letter, as shown in Fig. 1. To make the card shown in Fig. 2 more definite, a space at the bottom of the card is marked "assembly," and a cross is placed next to it if the machine to which the card belonged has an assembly drawing. See Fig. 2. Thus, with one glance at the index card, one has the numbers of sheets of drawings used on each machine, which sheet contains any particular part, where to find the sheet wanted, and whether there is an assembly drawing of the machine. These index cards are filed away in pigeon-holes numbered with letters corresponding to the first letter of the name of the machine.

14-INCH LATHE.
MACHINE LETTER
B
SHEET NUMBER–501.
SCALE–1-2 SIZE.

FIG. 1.

14-INCH LATHE.

MACHINE LETTER—B.

| Drawing Number. | Drawer. | Case. | Detail. | |
|---|---|---|---|---|
| 501 | B | 1 | 0 | Carriage. |
| 502 | B | 1 | 0 | Head Stock. |
| 503 | B | 1 | 0 | Tail Stock. |
| 504 | B | 1 | 0 | Bed. |
| 505 | B | 1 | 0 | Legs. |
| | | | | |
| | | | | |
| | | | | Assembly + |

FIG. 2

Now, regarding a system of marking patterns and indicating the number of castings used from each on a machine, I decided that the index card shown in Fig. 3 would suit all my requirements. At the top of the card is the name of the machine, and directly under is the machine letter; at the left are the drawing and the machine letter, and directly under that can be found the number of the sheet of drawings. In the center are the names of the patterns; in the first column on the right, the number of castings used for each pattern on one machine, and the last column gives the number of the pattern. For example, if a casting for a feed-worm is needed, I look for the 14" lathe in the pigeon-hole marked L. I find the pattern number for the feed-worm to be No. 138; I find that there is one used on a machine and that the sheet of drawings that contains the feed-worm is 501. I now have the desired information and despatch a boy to get pattern No. 138 for 14" lathe, and send it to the foundry, as the card tells me that is what I need for one machine. This system saves a great deal of time, and the drawings and blue prints last longer because they do not receive so much handling.

14-INCH LATHE.

MACHINE LETTER—B.

| Drawing Letter, B. | Piece. | Number of Parts Used. | Pattern Number. |
|---|---|---|---|
| Sheet No. | | | |
| 501 | Apron. | 1 | 133 |
| 501 | Hand Wheel. | 2 | 135 |
| 501 | Feed Worm. | 1 | 138 |
| 501 | Bed. | 1 | 140 |
| | | | |
| | | | |
| | | | |

FIG. 3.

Having my patterns distributed among a number of foundries, if I wanted a pattern and it was not where it should be, of course I would know it was in the foundry, but in which one could not be told. For this reason I adopted the system shown in Fig. 4. At the top of this card is written the name of the machine, directly under, the machine letter and the name of the piece; at the left is the pattern number; at the right a space is left for the signature of the foundry holding the pattern; at the bottom the dates the pattern is received and returned and the number of castings ordered.

14-INCH LATHE.

MACHINE LETTER—B.

| Pattern Number. | Piece. | Received by. |
|---|---|---|
| 140 | Bed | |
| | | |
| | | |
| | | |
| | | |

Date Received.............. October 7-98 | Number Ordered,.......... 1
Date Returned..............

FIG. 4

Some of the readers of this article may say that there is a lot of red-tape and unnecessary printing to this system, but I find that the time saved by adopting it more than pays for the printing. Then, too, I always find the patterns returned in good condition, because I have the receipt for same which holds the foundries responsible for the patterns.

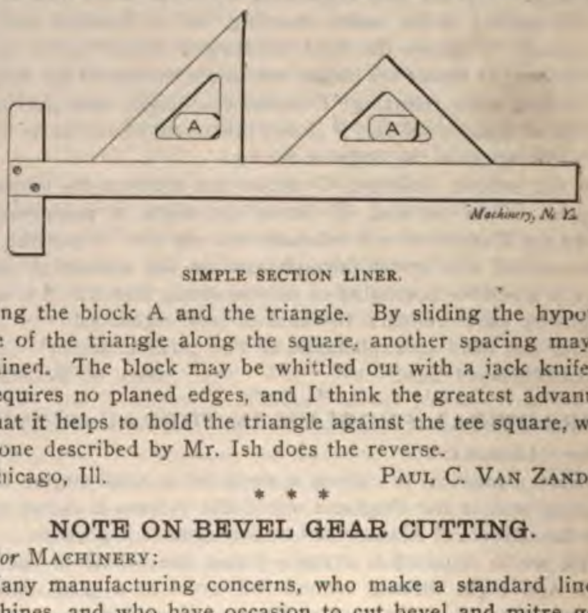
A. NOTROTH.

* * *

## SECTION LINER.

*Editor* MACHINERY:

In your November number I noticed, under "Shop Kinks," a section liner for draughtsmen. There was one suggested to me while I was attending Purdue University which is easier to make and to operate, besides giving two spaces. It consists of a piece of thin wood, cut a little smaller than the opening in a triangle, as shown in the sketch, and it works by alternately sliding the block A and the triangle. By sliding the hypothenuse of the triangle along the square, another spacing may be obtained. The block may be whittled out with a jack knife, as it requires no planed edges, and I think the greatest advantage is that it helps to hold the triangle against the tee square, while the one described by Mr. Ish does the reverse.



SIMPLE SECTION LINER.

Chicago, Ill. PAUL C. VAN ZANDT.

* * *

## NOTE ON BEVEL GEAR CUTTING.

*Editor* MACHINERY:

Many manufacturing concerns, who make a standard line of machines, and who have occasion to cut bevel and mitre gears on automatic bevel gear cutting machines, may have some difficulties in cutting certain gears, or possibly they think it is much easier to cut bevel gears, such as shown in the accompanying sketch, on universal milling machines. It can easily be seen that it would be difficult to lay off the depth of the tooth on the large end. To cover such cases, and to make the setting of the cutter easier for the operator, especially for one whose knowledge of gear calculations is limited, the following method was determined upon. It can be used on any style of bevel or mitre gear that can be cut on an automatic gear cutter, where the feed, instead of being at right angles to the pitch cone is at right angles to the axis of the gear, as, for example, in the "Brown & Sharpe" automatic bevel gear cutter. On a universal miller the gear would be placed at such an angle that the line O H in the sketch would be parallel with the direction of the feed, and the cutter would be fed in to the required depth D H.

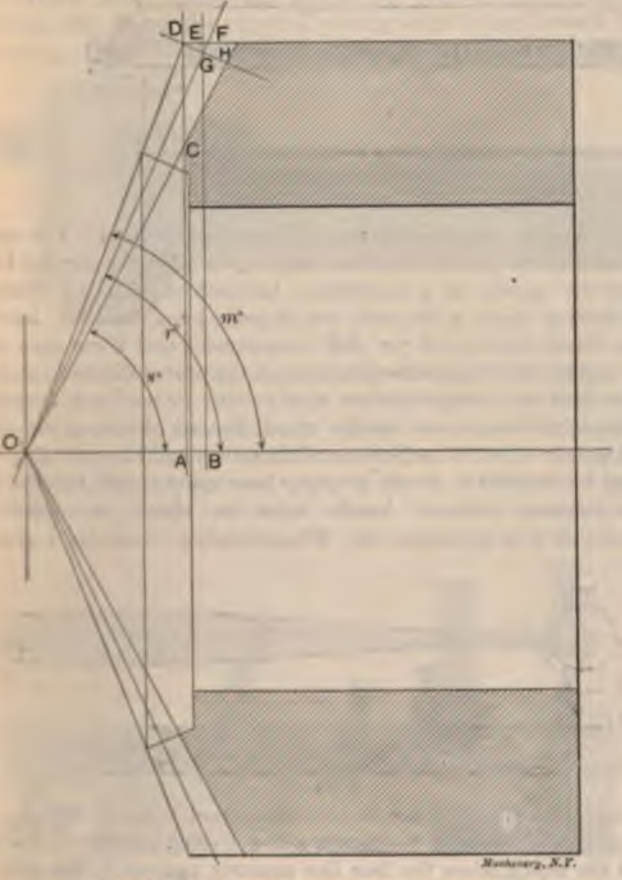


DIAGRAM TO ILLUSTRATE SETTING OF CUTTER.

When the gear blank is stationary and the cutter is set to the required angle s, the depth the cutter is moved into the work is not D H as before, but D C. To determine the line D C on any bevel gear having a diametral pitch is the object of this article.

Let line G B equal one-half the pitch diameter of any gear. D A equals one-half the outside diameter. Angle r equals one-half the pitch cone. D G is equal to $\frac{1}{\text{Pitch}}$. Then angle D G E is equal to r, being the complement of O G B. The sine of angle r times $\frac{1}{\text{Pitch}}$ is equal to line D E, or A B. Line O B is equal to ½ pitch diameter of the meshing pinion or gear.

In triangle C O A, angle s equals angle at which gear is to be cut. The tangent of s times O A is equal to A C. A D minus A C is equal to D C, which is the required distance that the cutter must move into gear blank to obtain a perfect tooth.

Some may think it easier to lay-off a full-sized section and measure the distance with a scale, but where the feed is graduated on the machine it seems to me better to compute the exact distance in thousandths and use such graduation, and then there is no guess work about it.

E. M. Willson.

Madison, Wis.

* * *

## COUNTERBORING TOOL AND OTHER DEVICES.

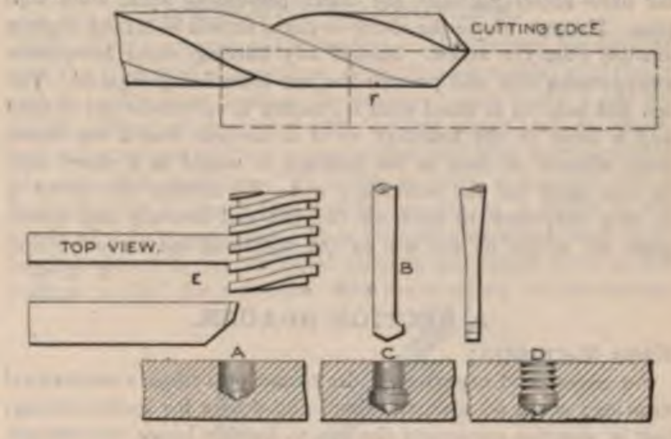
*Editor* Machinery:

It often happens on small work that thin pieces have to be tapped with a small tap, and that the holes must not be drilled clear through. To get as many threads as possible, the piece has to be tapped right down to the bottom, and the result is that in this kind of work many of the taps break off. There is a way to prevent this breaking off of the taps. First, with a common flat or twist drill, such as shown in the accompanying sketch, drill all of the holes down as far as you want the thread to go. After this take a drill, such as the one shown at B, and drill down, say, 1-16" or 1-8" more, as shown at C. This drill will counterbore the bottom and give the tap a chance to go clear down. The drill shown at B is only a flat drill, the same size as the first one, but ground one sided, as shown in the figure. When drilling down with this drill it will start to counterbore at once, and as soon as it has made its size it will continue to bore that way. D shows the same hole after being tapped.

Any machinist who gives this simple tool a trial will soon find it a very useful one for many things.

Some years ago I worked in a medium-sized shop where we had quite a good deal of brass work. Among other things we had a lot of valves with double thread on the stem and nut.

When I first came to this shop the stem was cut in the usual way. First one thread was cut, then the gears were turned half way round and the other thread was cut. It was quite a job to make all these changes to cut each thread, and it caused a great loss of time. As I was cutting some of these valve stems one morning, the thought struck me that if I had a double tool just the pitch from one thread to another, I would be able to cut a double thread at one setting and to cut two valve stems in the time that it now took me to cut one. I went to work at once and made a tool like that shown at E. When it was finished I gave it a trial and it worked like a charm. There was another man in the shop doing the same work, and about two days later he came to me and said that the boss had been trying to bluff him by telling him that I was making two valve spindles in the same time he took to make one. At that time the boss did not know himself how I did it. I showed the inquirer how it was done and the next day he was using the same sort of a tool.



A FEW KINKS.

Every machinist knows how easy it is to break a twist drill when drilling brass. The kink I am going to tell about is nothing new and I have been using it for years. The wonder to me is that so few have caught on to the trick. When I have to drill a lot of holes in brass, I take a common twist drill and grind its cutting edge with an oil stone, just rubbing the oil stone up and down once or twice, holding it exactly in line with the center of the drill. The end ground off would be in the same state as a straight fluted drill, as shown exaggerated at F. Grinding off the cutting edge of the drill will prevent the drill from screwing into the brass and from breaking when it is nearly through. It will also save the operator's hands. The cutting edge needs only to be ground off about 1-100 part of an inch.

If the drill is to be used afterwards for steel or iron, it can be used as it is or ground off again in a few seconds.

Old Subscriber.

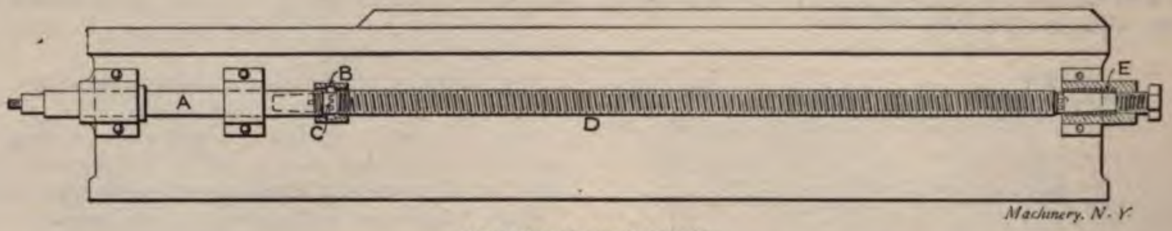
* * *

## REVERSIBLE LEAD SCREW.

*Editor* Machinery:

It is often requisite to cut an accurate screw in a lathe the full length of its center distance. With a new lathe this is an easy matter, but with a lathe that has been in use for some time it cannot be done with any degree of accuracy owing to the unequal wear in the lead screw, unless the lathe has been in continuous use on full length work. The inequality of wear is due to the greater portion of work being short or half length and to the pull on the screw being in one direction. In fact, some lead screws assume the buttress shape of thread toward the head stock, while the part toward the tail end is as good as when it left the factory.

With the present construction of the lead screw there does not appear to be any remedy for this. To trim the threads to their proper shape would make them too light for practical use, and to propose a new lead screw to the proprietor of a machine shop would be as bad as committing a felony. It seems to me that the solution of the difficulty would be to have the lead screw reversible. It is evident that with a reversible end screw, the wear would be evenly distributed throughout the length of the screw by reversing the ends every three or six months.



Machinery, N. Y.

REVERSIBLE LEAD SCREW.

The sketch shows a reversible end screw which, I believe, with a few slight alterations, could be used to good advantage, as it possesses the rigidity of the solid screw, and does not take two days to be reversed. The stationary part of the screw is fitted with a clutch end C and a socket. The reversible part D is fitted at both ends with a clutch and has slightly tapering shanks. A right-and-left threaded nut B holds the stationary and reversible parts firmly together, the clutch preventing them from slipping. The part where the clutch engages should be turned slightly smaller than the screw. Should any burring occur from their engagement, this will prevent the nut from being injured. The tail end bearing is fitted with a bushing E to receive the shanks and it turns in the bearings, as it is obvious that if the shank were allowed to turn in the bearing, it would in a short time be too small for the stationary end. To reverse the screw it is only necessary to take off the tail end bearing and disengage the screw by the use of the right-and-left threaded nut.

T. B. C.

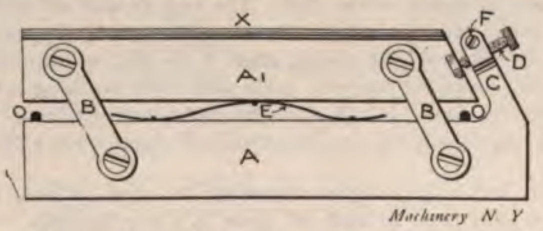
* * *

## A SECTION SPACER.

*Editor* Machinery:

An expert and experienced draftsman on ordinary mechanical drawings needs no mechanical spacing device for section lining; that is, practice accustoms the eye to quickly locate the straight edge so nearly uniform in spacing that the general appearance is good. On the other hand, there are times when an accurate division of space is desired.

The accompanying cut is one of many devices which can be used for this purpose. A $A_1$ are two pieces connected by connecting links B B, which allow $A_1$ to be moved between stop pins O O and regulating screw D. A is provided with arm C through which is threaded the screw D, which may be turned in and out for the required width of space. F is a binding screw so that D may be made to move with the degree of friction necessary to keep it from jarring loose when set as desired. $A_1$ is bevel-edged at X for pen lining. Between $A_1$ and A is a light spring, which may be made to act as a spreading-apart spring or to draw them together at O O, as might be most convenient to the operator. The operation of this device may be readily seen by those accustomed to section lining, but I must add that proficiency in using any device of this kind is only attained by practice.



Machinery N. Y.

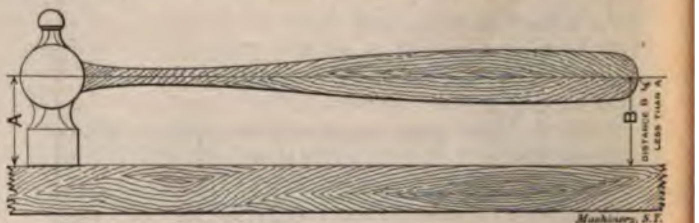
**Francis W. Clough.**

Boston, Mass.

## HAMMER HANDLES.

*Editor* Machinery:

The "loose pulley" illustrated in the December issue of Machinery is all right, but it is not the particular kind that the writer cares to meet. I notice that the editor has placed the sketch beside the obituary column, which appears quite appropriate. What I desired to mention, however, is the hammer that is dropping from the unfortunate gentleman's hand. The artist who drew the sketch evidently appreciates what the correct form for the handle of a machinist's hammer should be. What a difference there is between the properly-hung hammer, having an elastic handle and the club arrangement that some men use. A handle that has not been reduced to the proper dimensions near the head is a most tiresome tool for me to use, and I almost invariably hang a new handle myself instead of letting the shop carpenter do it. A carpenter understands a nail hammer all right and knows that it should properly have quite a stiff handle, but a chipping hammer handle must be elastic in order to make an easy working tool. When hanging a hammer I always have it so that the face is inclined inward towards the axis of the handle. That is the handle will not stand parallel to the top of the bench when the face lies squarely against it, but will be "hung in," as shown in the accompanying sketch.



Machinery, N.Y.

A hammer having a good hickory handle and reduced to the proportions indicated, is a comfort to use and "swings itself," as the shop saying goes.

**Nemo.**

Providence.

* * *

## HOW HE HARDENED THE DIE.

*Editor* Machinery:

One day, while I was at Smith & Black's, we had a new man come to work in the tool room. He was one of those slap-dash and let-her-go kind of men. The foreman looked him over well and started him in on a large blanking die, which was, if I remember rightly, for a pair of sugar tongs. He started in pretty well for a new man, made the die all right, and then went out in the smith's shop to harden it. Now, we used to have a fire out here just for the tool makers, as well as one used by the smith. The new man piled on the coal, got up a big fire, and then put in his die to harden. It was about twenty inches long, and I think it was of steel, 1 x 3 inches. The smith's fire was an ordinary one, about ten or twelve inches diameter, and he slapped the die on the top of it, put on the blast, and kept pulling his work back and forth through the fire, so as to try to get an even fire. He heated the die up after a fashion and then started for the hardening tank. Now, we did not have very good hardening facilities. All we had was a tub about 16" square and 20" deep, and there was about 10" water in it at the time. What did that fellow do but stick one end into the water as far as it would go, then pull it out, turn it over quick, and stick in the other end. He repeated this operation several times, then pulled the die out, pronounced it hardened, took it into the shop and polished it up, and then tried to draw the temper. The thing was hard at each end and soft in the center, and as soon as he started to temper it, it went all out of shape, like a sprung

n a bicycle. "Of all the poor steel I ever saw that is the
said he, as he took it up to the boss' bench.
it did go pretty bad," said the foreman, "and I guess
better go, too," and he went. A. P. Press.

* * *

## A NEW PLANER TOOL HOLDER.

ner tool holder for the economical use of self-hardening
d one which can be adapted to a wide range of work, is
n the accompanying cut, Fig. 1. The cutters used are of
ılar stock shape, and can be cut from the bar without
into shape, the required cutting edge being formed by
. The cutter is held by a slotted bolt through which it

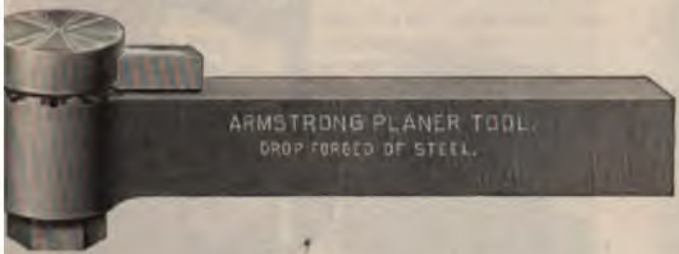


FIG. 1.

nd is kept from slipping sideways by being seated in
in the holder. The shank is drop-forged from steel, and
dened for durability. It will be seen from Fig. 2 that
is well adapted to working in close corners and under
ons, as the cutter can readily be set at any required angle
firmly in the required position. One of the special tools
ften used on the planer is the "goose-neck," but it is a

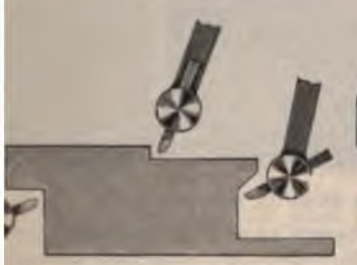


FIG. 2.

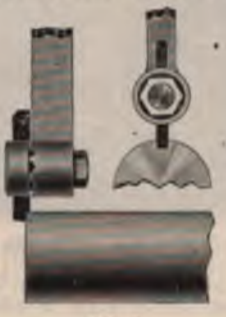


FIG. 3.

and expensive form to forge. This tool fills the bill
ely as shown in Fig. 3, where the cutter is reversed and
turned around so that the cutting edge is behind the
f the tool. Such a tool is of much value in cutting
, as there is no tendency to "hog in" and spoil the job.
l-holder is manufactured by the Armstrong Bros. Tool
y, Chicago, Ill.

* * *

## CASE HARDENING.

annual meeting of the Railway Master Blacksmiths'
ion there was an extended discussion upon case-hard-
hich is reported in the published proceedings that we
ast month, and from which we quote the following:

process of case hardening has not changed, materially,
ast few years. The principal materials used remain the
anulated raw bone, hydro-carbonated bone black, black
magnesia, sal soda, charcoal, and salt. These materials
nonly used in railroad shops and give much satisfaction,
e carefully and properly handled.

work, which is to be hardened, can be packed in cast, or
-iron boxes, sealing with fire-clay, or mud so as to pre-
gases from escaping as much as possible. The pieces
rdened should be placed about two inches apart in the
e vacant spaces are well filled, and packed with the
used for the case-hardening purpose. Should the box
ed with heavy work, as crank-pins, guides, etc., fifteen
hours of steady heat are necessary in order to secure
results. If, on the other hand, you have light pieces,
locks and pins, eight to ten hours will be sufficient to
hem to a good heat.

ork may be placed in the furnace, about 8 o'clock of a
and heated all day. At night close up the furnace, letting the box remain over night, and remove the next morning. Reheat the work and cool in cold water. Good results may be secured by using granulated raw bone. If using hydro-carbonated bone black, pack the pieces in the box and seal the same as before.

"Furnaces for case-hardening should be so constructed that the boxes will not have to be raised or lowered while being placed in or taken from the furnace. The heating space should be near the ground, and the fire-box and ash-pan below the surface. This refers to a furnace heated with soft coal. If the furnace is on the outside of a building, a stack or chimney about sixteen feet high will furnish draught enough to heat the boxes without the aid of a blast. Case-hardening furnaces, which are heated with fuel oil, are of a very different construction, the boxes being generally heated from the top. With coal it is, in most cases, from the bottom.

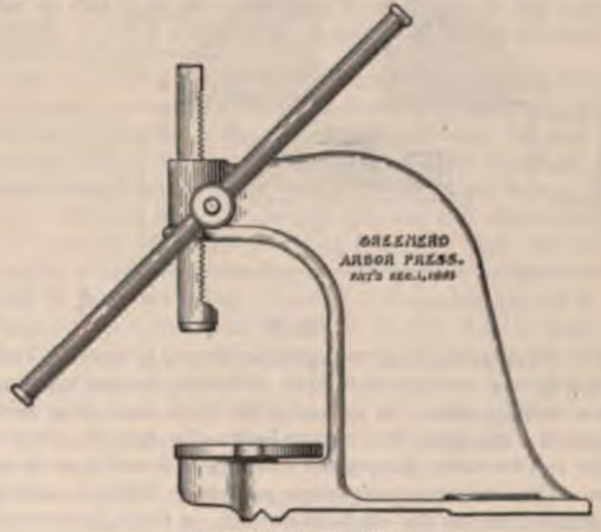
"The cooling tub is arranged so as to admit cold water from the end near the bottom, the cold stream thus running lengthwise along the bottom of the tub. This cold stream forces the hot water to flow over the top of the tub. When cooling guides, or long pieces, strips or bars of iron should be laid in the bottom of the tub, in order to keep the work about two or three inches from the bottom. In this way the cold stream flows under the work which is being cooled."

Another speaker said: "The way we do in our shops is to use potash and glue, the idea of the glue being simply to make the potash stick. We put on all the piece will take; if we desire more hardening we use a second coat of glue. We do not make the glue thin, but make it thick and put on all the piece will hold."

* * *

## A PRACTICAL PROBLEM.

It is likely that most of the readers of Machinery are familiar with the Greenerd arbor press, either from practical experience with it in the shop or from the extensive advertising it has received. Many of the latter class, having never had an opportunity to give one of these presses a practical trial, have probably felt somewhat doubtful of its ability to force a mandrel into a bore with the pressure that can be exerted by a sledge in the hands of a lusty mechanic. It is thought that a practical problem is involved in this device, of which it will benefit some of our readers to find the solution. The press shown in the accompanying outline sketch is one for pressing in arbors of a diameter up to 1½" and the largest diameter of work that can be centered under the plunger is 12". The length of the lever is about 23" from the end to the center of the shaft carrying the pinion. The diameter of the pitch line of the pinion is one inch.



TYPE OF ARBOR PRESS.

What pressure can a man easily exert on an arbor and how will that pressure compare with the average blow of a five-pound hammer? Suppose a 1½" arbor is forced into the bore of a pulley 10" in diameter by the pressure found in the first instance, what pull at the rim would be required to slip the pulley on the mandrel? Answers to these questions may be found either by experiment or calculation as the reader may elect.

## A NEW BORING TOOL HOLDER.

The illustration in Fig. 1 is of a new boring tool designed to be placed on top of the tool post slide of an engine lathe. It will be seen, by reference to this illustration and to the detail sketch in Fig. 2, that a shoe B, rests on top of the tool post slide and supports a swivel frame, C; the whole being clamped together by a bolt which passes through a cylindrical clamping beam D fitting inside the swiveled frame. This frame has two bearings, I ,which receive the boring bar

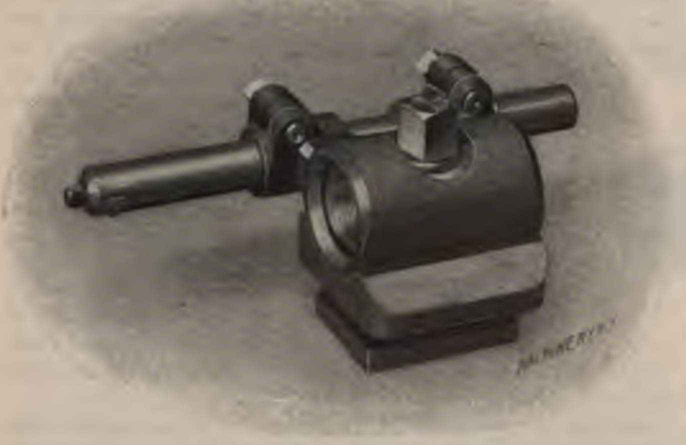
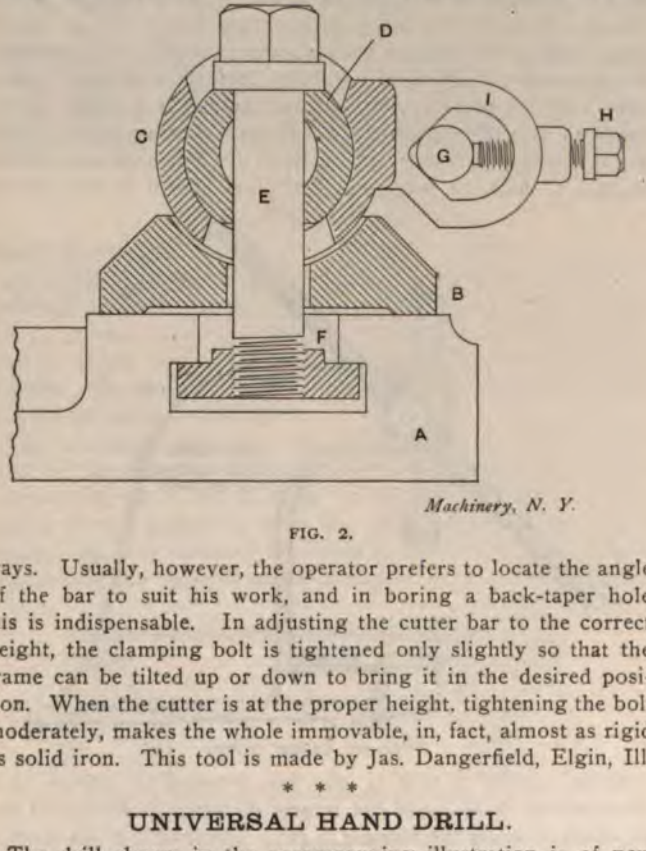


FIG. 1. BORING TOOL HOLDER.

Two forms of this holder are made; one like that in Fig. 1. in which the bearings have round holes adapted to receive round bars of exact size; the other, shown in the sectional view, has V-shaped bearings suited to octagon or other shapes of forged bars from ¼" diameter to the largest size required. In special cases the shoe may be made with a tongue to fit the slot in the tool post slides, thereby holding it exactly parallel with the lathe ways. Usually, however, the operator prefers to locate the angle of the bar to suit his work, and in boring a back-taper hole this is indispensable. In adjusting the cutter bar to the correct height, the clamping bolt is tightened only slightly so that the frame can be tilted up or down to bring it in the desired position. When the cutter is at the proper height, tightening the bolt moderately, makes the whole immovable, in, fact, almost as rigid as solid iron. This tool is made by Jas. Dangerfield, Elgin, Ill.



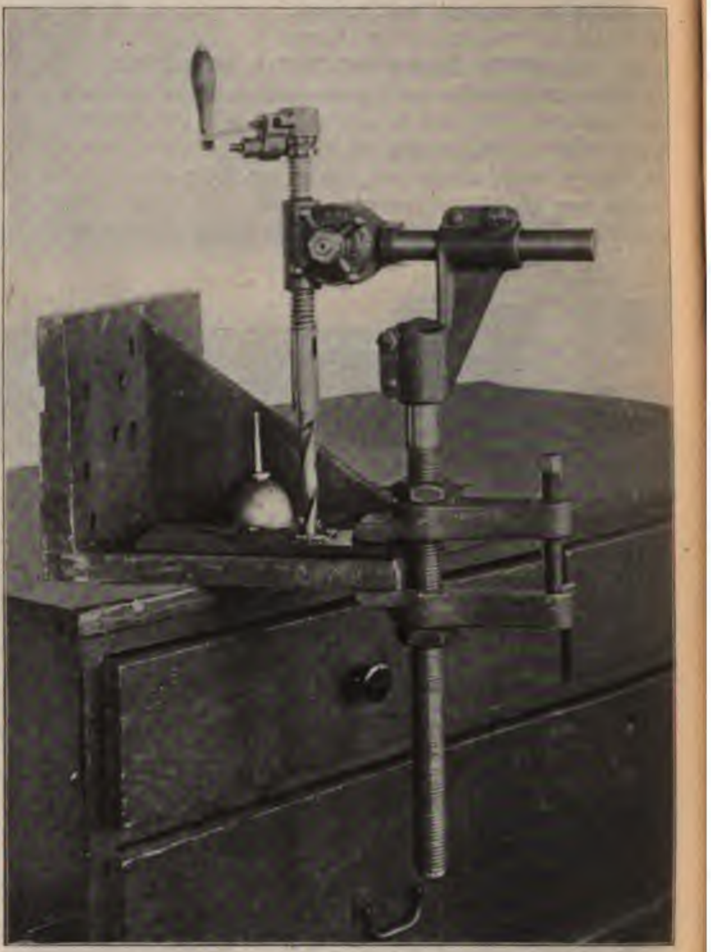
*Machinery, N. Y.*

FIG. 2.

* * *

## UNIVERSAL HAND DRILL.

The drill shown in the accompanying illustration is of new design and is intended for a wider range of work than can be accomplished with an ordinary ratchet drill. At the same time it can be used wherever a ratchet drill is applicable and is more rapid in its action because it has an automatic device which gives a regular feed when the handle is operated by the workman. The drill is universal and can be set at any angle. It is made in five sizes which adapts it to holes varying from the smallest to those 1½" in diameter. The feeding arrangement consists of a friction disc in connection with a worm gear which operates in the rod of the spindle and advances the drill at the required rate of feed. The speed of the feed is changed by tightening or loosening the friction wheel.



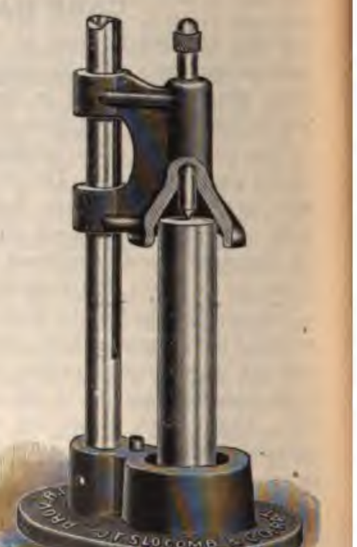
THE DRILL IN ACTUAL USE.

The handle can be changed so as to be used as a crank or as a ratchet working in either direction. The drill column can be readily attached to any kind of work and is found valuable for use on large work or in making repairs, because of its general convenience and rapidity. It is manufactured by E. D. Jones & Sons' Co., Pittsfield, Mass. The illustration is made from a photograph taken in the shop, which shows the drill as it appears in every day work.

* * *

## A NEW CENTERING TOOL.

A simple centering tool which is very convenient to have in a shop where much small lathe work is being done, is shown in the accompanying cut. The Severance centering tool, as it is called, is a combination of the principle of the bell center punch and an upright support, together with a cast-iron base. The upright shaft is splined and a key in the bell part keeps the bell centered over the recess in the base, in which the end of the piece being centered, is placed. The base may be screwed to the bench and the arrangement made a much more convenient scheme for centering the work than the old-fashioned bell center punch that has to be held in the hand. The tool need not be fastened down, however, as it has enough stability to stand alone and can be used



CENTERING TOOL.

ɔeing fastened if desirable to have it in different parts of . To avoid disagreeable noise and dangerous shocks to from the bell falling on the base after being used, a small lug is inserted in the base to act as a buffer. The center made of the best steel and is carefully tempered as such eeds to be to stand the rough usage that it will almost y receive in the average machine shop. The tool, as at made, will center diameters from 5-16" to 1½" and o 12". It is manufactured and sold by J. T. Slocomb & 'rovidence, R. I.

* * *

## HOW AND WHY.

**RTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.**

**details and name and address. The latter are for our own convenience and will not be published.**

T. W.: Will you kindly give me directions for bal- vertical engine. Should the cross-head, piston, and ıg-rod be attached to the shaft and balanced with it? I n told that they should be but I do not think so.

ı page 361 of the July, 1898, issue, you will find informa- alancing a vertical engine. Aside, however, from an ex- of the principles involved, the conclusion is reached ɔnly satisfactory way to balance the engine is by experi- ıe cross-head, piston and connecting-rod cannot be cor- lanced by a revolving counterweight; but the only feasi- is to couple up the engine and balance these parts as possible by the use of such counterweight. The engine ade to run smoothly by this process, and that is all that ed.

---

eferring to the article on "Wireless Telegraphy," which in the November issue of MACHINERY, T. I. J. asks: he circuit of the cells of battery R, as shown in Fig. 2, the armature of the magnet B? The diagram shows point of contact. 2.—Can all of these magnets not be in series in their separate circuits and without the use nces in shunt as shown? 3.—Also, please describe more resistance tube A, Fig. 3. What inside diameter is best receive a coil which will give, say an 8" spark between y terminals? How far apart should the heads of the rs be and what kind of filings should be used, and of , fine or coarse? 4.—When should the hammer strike

Fig. 2 of the article referred to the artist neglected to hort line connecting the right hand side of lever with bove, which connects the ends of magnet coils C and D. ng in this line you will find that the two coils are con- parallel with the battery. The coils can be placed in thout affecting the operation of the apparatus, but the es cannot be discarded, as their object is to prevent at the break points. Sparking must be prevented at nts, for if not, radiations would be developed by them, would act upon A and thus confuse the signals. The ction to the series arrangement of C and D is that the D would vibrate, and thus render the signals less clear. A is made about ⅛ of an inch in diameter, inside, and nce between the ends of the wires is about the same. cel filings are considered the best for the filing. The ıent illustrated in your sketch is all right, but if the two were placed in parallel the sounder could give regular e tapper is under the control of the high potential cur- ing from wire W, for each time it raps the tube, it de- , as it is expressed, which means that it restores the tate of high resistance. If the high potential current the instant when a tap is given, this will be the last one, the next one should be given there will not be a high current to break through A.

---

A. L. asks for directions for grinding ammonia cocks. that he has difficulty in making them tight and that, ıding a while, he finds that rings appear on the sur- Ve referred this question to Mr. Francis H. Boyer, le, Mass., who replies as follows: To grind ammonia isfactorily a lathe is required. Put a dog on the round place the plug on the centers with the tail stock run . Have the body of the cock so that it can be pushed plug and run your lathe on quick speed. Wipe off the plug and bore, place on the plug a thin coating of flour emery and oil and then grind for short periods, say eight or ten seconds. During the grinding every ten or fifteen minutes wipe off the plug and the bearing in the body and apply clean emery. Should you not have a lathe convenient, clamp the round end of the plug in a vise with soft jaws, putting pieces of sheet lead or copper between the jaws and pin, and then grind the same as for lathe work, turning the body of the cock by hand. To avoid cutting rings or scores in the surfaces, lift the body from the plug every few seconds, clean off the surface often and apply new emery. This will give a most satisfactory result.

---

29.—J. T. B.: Will you kindly give me some information on draw plates used in the foundry? I would like to see a sketch of one if possible.

A.—Draw plates are commonly made like the sketch at the left in Fig. 1, which consists simply of a small metal plate with a hole drilled and countersunk in each end for wood screws and a ½" tapped hole in the center into which a threaded rod can be screwed for withdrawing the pattern from the mold. Another form of draw plates, which we believe is patented, is shown at the right in the sketch. It is made in such a shape that, by boring three shallow holes in the pattern with a bit, the draw plate will fit into these holes.

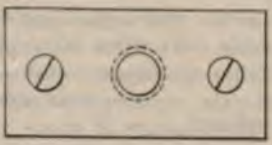


FIG. 1.

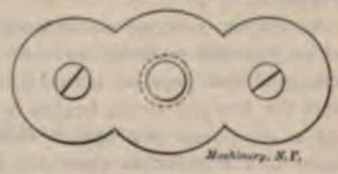


FIG 2.

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30.—H. W. S.: I would like to learn more about lubricants and the subject of lubrication. You will do me a great favor by informing me how I may best obtain a thorough understanding of the subject.

A.—A book by Redwood upon "Lubricants, Oils and Greases." price $1.50, and another work by Robert H. Thurston, on "Friction and Lost Work in Machinery," price $3.00, will probably help you to a better understanding of the subject. We can supply these books at 10% discount from the list price.

---

31.—H. T. H.: 1.—I would like to know what is the best method of treating steel to prevent it from rusting. The steel is constantly exposed to the weather and occasionally two pieces of the metal rub together. Of course there are many ways of treating steel that answer the purpose where there is no rubbing; but in this case any coating is soon worn off and corrosion begins. 2.—Will you also please state how barbed wire, used for wire fences, is treated.

A.—1. There is no way to prevent steel from rusting other than by giving it a coating of some other material which will not corrode and which keeps the air and moisture from the steel. It is evident that if steel were subjected to some treatment which acted throughout the metal, you would no longer have a piece of steel. It is the nature of steel to rust, and if it were so changed that it would not rust, it would no longer be steel. In this connection it may be interesting to note several methods that are used to prevent rusting. Tinning is a coating applied by first scouring the metal, then dipping it in acid, then in grease and finally in melted tin; galvanizing consists in coating the metal by a similar process with zinc. Tin is negative to iron, and zinc is positive to iron, electrically, so that when the coating becomes injured, the zinc will actually protect the iron while the tin will cause an action to take place which will produce rust. Nickel plating is negative to iron and does not protect it as well as galvanizing, but it is a durable coating. Iron or steel can be protected for a long time by dipping in molten tar. Linseed oil, on oxidation, forms a rubber-like substance which has great preserving power and when used either with or without coloring matter is a good preservative. 2.—Barbed wire fences are generally galvanized.

---

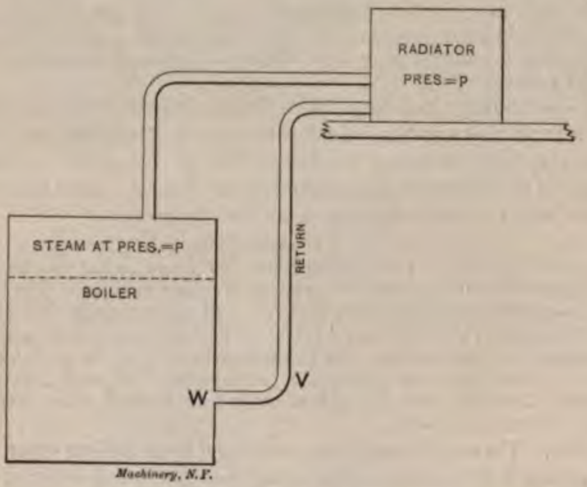
32.—R. T. W.: 1.—In the February, 1897, number of your paper, you published an article on annealing Mushet steel. Has the annealing of this class of steel come into extensive use since that time and do you know of any later methods of performing the operation? 2.—Does the steel, after annealing, show the same properties of self-hardening when heated again?

A.—On page 263 of the April, 1898, number you will find a little information upon annealing self-hardening steels. We do not know of any later methods and we think that in most shops the annealing is not very generally practiced because it is done with difficulty and steel can generally be ground into the shape desired. 2.—Upon heating again, the steel will regain its former properties. Of course, where milling-cutters, taps and dies and similar tools are made of this steel, it must be annealed. In hardening, the steel should be heated to a bright yellow and cooled in an air-blast.

---

33.—H. H.: I have been piping a house for steam heating, using an upright shell boiler for a heater, placed in the cellar. When I start the fire and the boiler begins to make steam, the water will go out of the boiler, through the return pipe, and fill the radiators. If I close the valve in the return, however, and do not open it until there are two pounds pressure in the boiler, there is then no difficulty with the water backing up into the radiators. Please tell me what the trouble is and how to remedy it.

A.—If you will put a check valve in the return pipe near the boiler you will probably have no trouble. We think the explanation of this peculiar action is as follows: Suppose that you start the fire and steam begins to generate, reaching a pressure, say of ½ pound per square inch. The pressure P above the water in the boiler as shown in the sketch will then be 14 7-10 pounds due to atmospheric pressure, plus 5-10 pounds. This steam rushes into the radiator, which is cold and acts as a condenser. After partially filling the radiator, it condenses, leaving the pressure P in the radiator something less than atmospheric pressure, or in other words producing a partial vacuum in the radiator. Steam continues to pass off from the water, keeping up the pressure in the boiler, while as at this stage it is generated very slowly and the radiator is comparatively cool, it continues to be condensed when it reaches the radiator. The return pipe which connects the radiator with the bottom of the boiler, therefore connects the water at the higher pressure P with the radiator at the lower pressure P and the water is compelled to flow through this pipe into the radiator. If the return pipe were connected with the boiler near the water line, the water would vaporize and the pipe would fill with steam instead of water; but at the bottom of the boiler the water is comparatively cool, so that this action cannot take place and the pipe is filled with water. When you have a higher steam pressure in the boiler, steam is generated rapidly and is somewhat hotter so that the radiator is heated quickly and the condensation does not take place to so great an extent as to produce a vacuum. The pressures in the system are consequently balanced and no trouble ensues.



* * *

The Arthur Company Machine Works, 188-190 Front street, New York, are doing an increasing business in high-class work and are constantly adding to their plant. In their gear department we have examined two 6 foot machines of entirely new design, and found them being tested, with the most satisfactory results, on 50 inch wheels of 2 diametral pitch. All their large gear cutting machines are designed and built on the premises, and these two are their third and latest type. So thoroughly have these machines met expectations, that two more of the same style, powerful enough to carry cutters up to 8 inches diameter and cut still larger pitches, are now under construction to meet the growing demands for greater diameters and pitches in cut gearing.

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## OBITUARY NOTES.

Philander P. Lane died at his home in Norwood, Ohio, December 7, at the advanced age of seventy-eight years. He entered the employ of a machinist when nearly twenty-five years old, but made rapid progress in the business and established a small repair shop of his own in 1850 at Cincinnati. The firm of Lane & Bodley was formed in 1852, and the business has been carried on under the firm name ever since. Mr. Lane was greatly interested in educational matters and took an active part in the founding of the Ohio Mechanics' Institute and Industrial Expositions.

Charles Potter, the inventor of the Potter printing press and president of the company manufacturing his presses, died in Plainfield, N. J., December 2, aged seventy-five years. He first engaged in the manufacture of printing presses in 1854, being associated with George H. Babcock. The venture not proving successful, the firm was dissolved and Mr. Potter began building cylinder presses in Westerly, R. I., in 1856. The firm of C. Potter, Jr., & Co. was established at Norwich, Conn., in 1865, and a new factory was built at Plainfield, N. J., in 1879.

William A. Durfee, a prominent mechanical engineer and inventor, died November 9 at the age of sixty-six years. Mr. Durfee was widely known as a writer on scientific subjects, and was a contributor to many engineering publications.

William H. Warren, the inventor of the celebrated Warren radial drill, died at his home on December 5th, aged 61 years. Mr. Warren had been engaged in the manufacture of machinery at Worcester, Mass., for many years.

Mr. John A. White, who was recently found dead in his office from gas asphyxiation, was one of the most prominent business men of Dover, N. H. He was a director of the John A. White Company, manufacturers of wood working machinery, Dover, N. H. This business was first started in Concord, N. H., by B. F. Dunklee in 1864. In 1873 it passed into the hands of Mr. Allen, who four years later sold out his interests to the present company. In 1891 the business was moved to Dover, and has since been conducted under the name of the John A. White Company. Mr. White, at the time of his death, was 61 years old.

MACHINERY.

Vol. 6. February, 1900. No. 6.

## A MODERN DRAFTING ROOM.

### ONE IN WHICH THE HEATING, LIGHTING AND VENTILATION ARE SPECIAL FEATURES.

While in most modern manufacturing establishments the drawing office is regarded as a very necessary and important department, there are not many shops, we will venture to state, that have as commodious and well appointed rooms for the draftsmen as are provided in the recently finished office of the Schenectady Locomotive Works. It often occurs that the increase of business that comes to a prosperous company absorbs the most of their attention in the building of new shops and providing them with tools to meet the increased demands for their products. Meanwhile the drafting department becomes in a congested condition and is allowed to remain in that state for an indefinite period. When at last, in such instances, it becomes imperatively necessary to provide more room, the addition is often one that merely increases the floor space, while other conditions necessary to make such a room a comfortable and healthful working apartment receive no consideration whatever. In the office referred to, however, an attempt has been made to realize as far as feasible the ideal conditions which should exist and from a personal examination we may state that these conditions appear to be generally met.

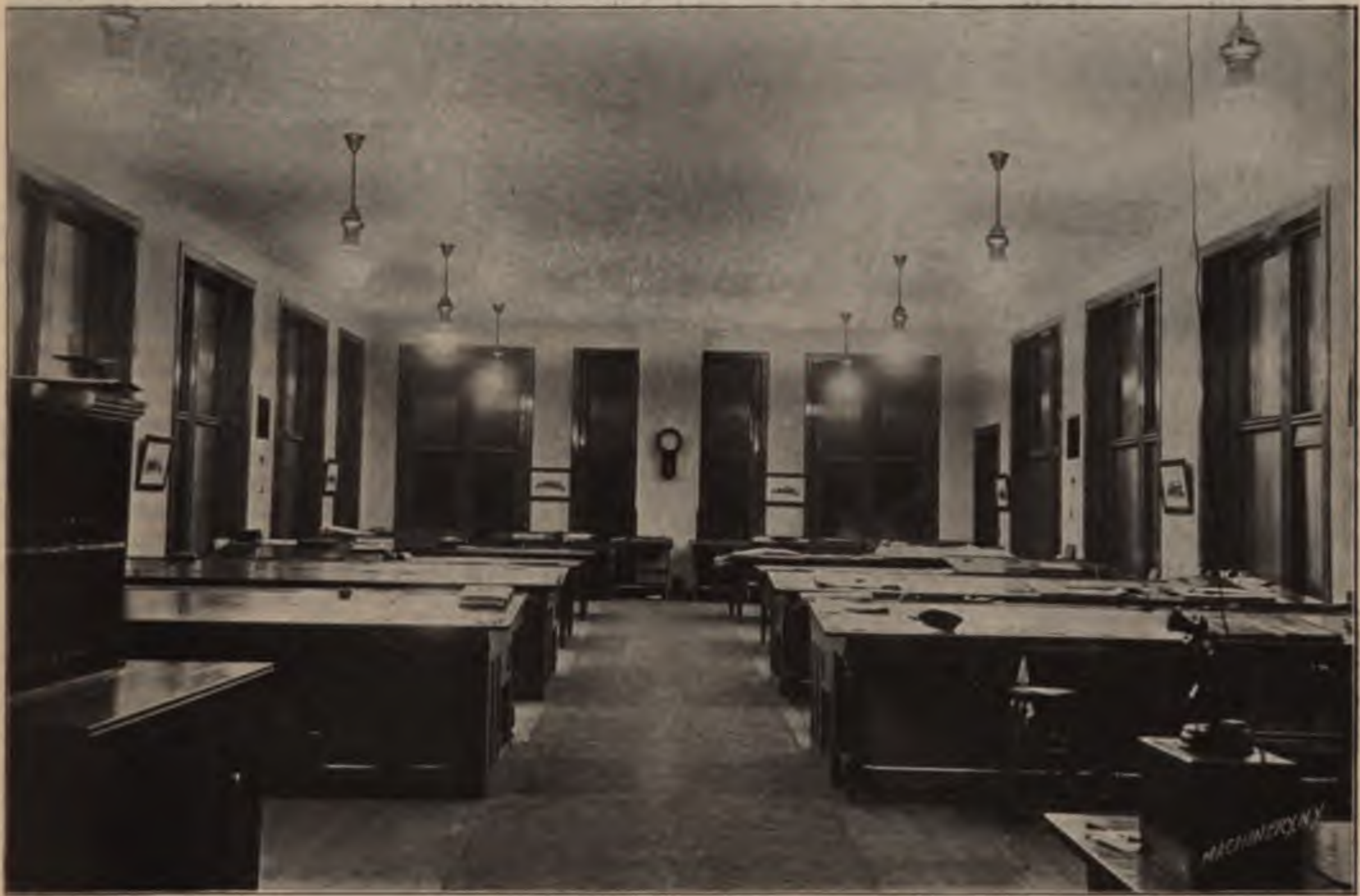


*Fig. 1. View of the drafting room of the Schenectady Locomotive Works. The photograph from which this cut was made, was taken at night by the artificial illumination. The view shows a portion of the main room without the bays.*

During the past summer the general offices of the company were enlarged and at the same time the inadequate quarters of the drafting department were extended to relieve the existing congestion. Considerable thought was given to the general design and arrangement of the extension, and particularly to that for the drawing office. It was held by the parties designing the additions that the first requisite of such a department is that its rooms shall be healthful and comfortable; and to realize this condition, there must always be a constant and plentiful circulation which shall at all times provide fresh air at the proper temperature and at the same time remove the impure air. The second requisite and the one usually regarded as first, is, of course, plenty of light with a general absence of shadows. In the drawing room under consideration, the conditions mentioned are fulfilled and also many more that go to make up a well appointed department.

#### The Circulatory System.

It is, of course, necessary to provide artificial means for maintaining a constant circulation of air under all conditions of weather and temperature and also quite an elaborate system of hot and cold air pipes with suitable mixing dampers so that in winter there shall be no question of the air being fresh and still at the proper temperature. The Sturtevant system was installed and the exhauster is shown with some of the piping in outline in Fig. 4. The exhauster is directly driven by a General Electric motor and the fresh air, as it is drawn through, is tempered by passing over the coils of a steam radiator. The main part of the radiator is set directly in front of the fan and is so arranged that the tempered air may be by-passed, or it may be still further heated by passing over another radiator. The double-duct system of piping is used, one pipe being for hot air and the other for cold air. Mixing dampers are placed at the base of each flue and they are so arranged that any desired mixture of tempered or hot air may be obtained in the flues. Chains for operating these dampers pass up through the flues to the rooms above and will be observed in some instances in the engravings, Figs.

1 and 2, the chains being provided with handles for manipulation. As will be noticed by reference to these cuts and Fig. 3, the fresh-air registers admit the air to the room at a point about eight feet above the floor and the registers for the escape of the vitiated air are at the floor level. The latter communicate with a ventilating flue having its opening on the roof. The circulating system is expected to entirely change the air in the room four times an hour or once every fifteen minutes and as the cubic capacity of the room with its bays is probably over 50,000 cubic feet, it is evident that sufficient fresh air will be constantly supplied for a larger number of persons than will ever be employed in the department. The entrances for the fresh air being at the height given, a draught is avoided and the air is disseminated throughout the room without any perceptible movement.

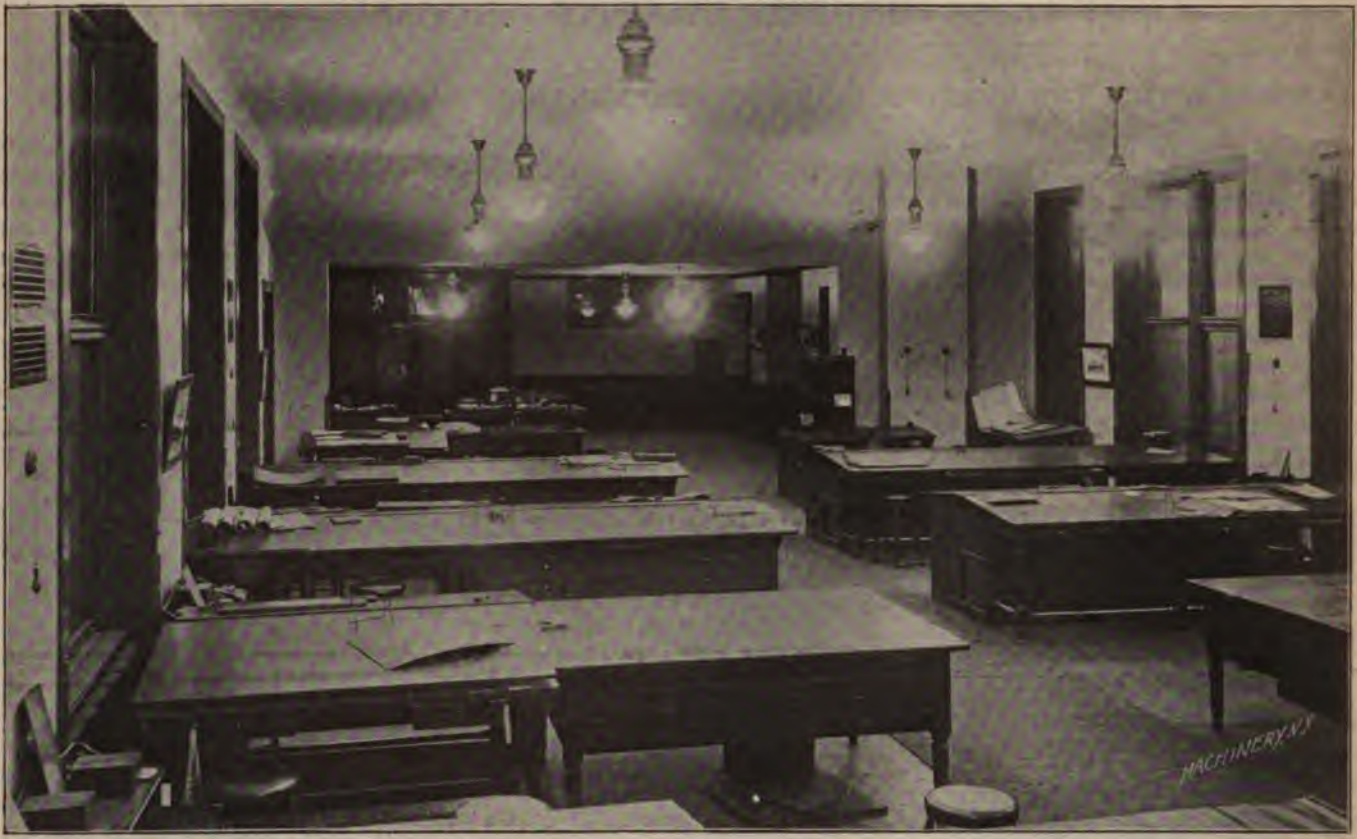


*Fig. 2. Another view of the drafting room of the Schenectady Locomotive Works, taken from the opposite end of the room and also by artificial illumination. The vent registers show on a level with the middle of the windows.*

The circulatory system includes the heating of the room and bays, but to provide for emergencies, steam radiators are placed at the windows, so that there ought never to be any trouble in keeping the office at a comfortable temperature during the coldest weather.

**The Lighting Arrangement.**

The photographs, from which the two engravings showing the interior of the room were made, were taken at night by artificial illumination. It is quite evident that the artificial lighting leaves little to be desired, although the cuts scarcely do the subject justice. The photographs showed considerable halation around each light, thus giving the effect of a glare which is entirely absent in the room itself. The apartment is lighted by inclosed arc lamps manufactured by the General Electric Co. as were the dynamo for the lighting system and marine type of vertical engine driving it. The arc lamps are inclosed in ground glass globes which diffuse the direct rays of light and throw the greater portion against the white ceiling to be reflected in all directions throughout the room. The walls, also being white, assist in the scheme of general reflection and diffusion so that

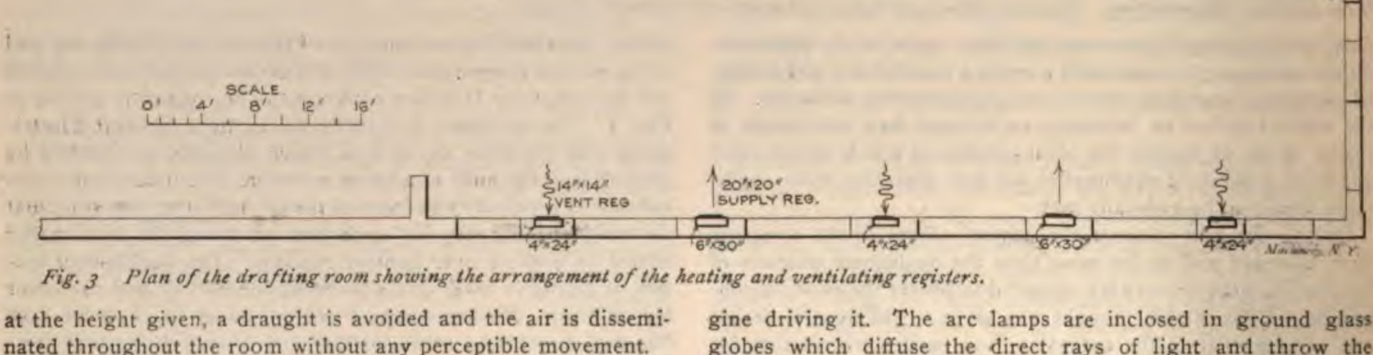
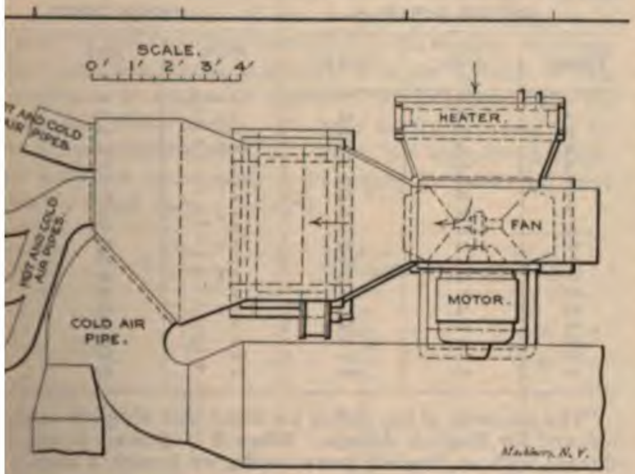


*Fig. 3 Plan of the drafting room showing the arrangement of the heating and ventilating registers.*

ntire room is filled with a soft white light that appears to no definite source and thus causes an entire absence of ows. It is needless to state that the effect on the eyes is restful and is an agreeable contrast to most artificially d rooms.

ile the artificial lighting is so successful, it is not more so that afforded during the daytime, which is, of course, of the importance. The windows are large and numerous and single panes of ribbed glass in each sash. The ribbed glass he peculiar feature of admitting practically as much light ordinary glass, but the light is broken up so that the rays iffused in all directions. The room is filled with a soft ed light and there is a noticeable absence of shadows. The ws being on all sides of the room, the light always comes ly from the sun through some of the windows, but the s are scarcely necessary on account of the diffusing power ribbed glass. There is one feature of the ribbed glass night be objected to, and that is that outdoor objects cane discerned through it, and it is therefore not possible to the eyes by looking at distant objects. The changing of cus from near to far objects is a grateful relief when the become tired, but in such a large room as the one in questhis objection is probably not of much weight.



PLAN OF THE FAN, MOTOR, HEATER AND HOT AND COLD AIR PIPES.

### Other Features.

drawing tables are solid, well-built pieces of furniture hardwood tops. They are provided with drawers for the tion of paper, drawings and tracings in progress and the al paraphernalia of the draftsmen. Most of the tables ouble, as shown, with the tops sloping in two directions, so work can be carried on at both sides without interference. arrangement favors the grouping of the draftsmen in diviworking on a common subject so that instructions may be by the leader without interfering with the general order room. It favors a clear understanding of the work in ess by the men in the different divisions and leads to more al accuracy of the drawings, to say nothing of considerably sing the amount of work done by the whole department.

arge part of the work, especially on the largest drawings, e without a T-square and without the customary drawing-. Heavy paper is used which lies smooth on the hardtops of the tables and lines are laid out by triangles and asses, all lines being located from a common center line or e line which is laid out at the beginning of the drawing. smaller drawings and details the ordinary board and are is used the same as in ordinary practice.

completed department, as it now stands, includes two bays were a part of the old drawing office. One of the bays contains tables for draftsmen and also a fireproof vault for eservation of the drawings, tracings and other records of epartment. The fireproof vault is two stories high, the part being used for the reception of the books and records general office. The other bay also has desks for draftsnd a toilet room. Lockers for each employe are also profor hats, coats and other individual belongings.

## PRINTING TITLES ON DRAWINGS.

A recent issue of the "American Engineer" contains a letter by Mr. F. M. Whyte, mechanical engineer for the New York Central Railroad, regarding a method which he uses for printing the titles on tracings by the aid of type and a printing press, instead of lettering the titles freehand, or with instruments, as is usual. As the idea is somewhat novel, and is evidently quite practicable, we reproduce the main portions of his description. He writes:

"In regard to the use of a printing press for printing titles on tracings, we are using a small handpress for this purpose, the frame of which measures 4 by 6 inches. When it was first proposed to purchase a printing press the one we have was considered sufficiently large; but it has been remarked several times since that it would have been better had we purchased a larger one. The length of the frame given above limits the length of the title, but we find it large enough for the purpose, as we try to make the title as short and expressive as possible. We have three fonts of type.

"I might tell you our experience which practically drove us to the adoption of a handpress. First, it costs considerable to put titles on drawings, whether the work is done with the usual drawing instruments or freehand. To reduce this cost, we tried first to use a rubber stamp, but the ink which we found would work satisfactorily with the rubber stamp would not give a print, so that, after putting the title on with the stamp, we would have to turn the tracing over and ink it on the back with black drawing ink. This, of course, was no great improvement on putting the titles on by hand. We found we could not use black ink on the rubber stamp, because the gasoline used for removal of the ink from the stamp after using it would destroy the rubber type. It was also difficult to get a perfect impression with the rubber stamp.

"The first difficulty experienced with the hand press was that the ink would not dry fast enough after the title had been put on the tracing, but this trouble was overcome by using a light, fine powder to absorb the ink, so that we now take a print from the tracing immediately after titling it. Fine powder should be used, because, otherwise, the large flakes of coarse powder will overhang the edge of the letter and produce ragged edges. We use the ordinary quick-drying printer's ink for our press. The first cost for us was $22.50 for the complete outfit, and it is believed that the first month or two's saving would cover the entire expense."

It is necessary to scrape the surface of the tracing cloth for the reception of the printed titles if the drawings are made on the glossy side. The following is the list of materials that I use: 1 press, 4 by 6 inches; 3 Hemple quoins and one key; 1 lot assorted wood furniture; 5 lbs. 2-point L. S. slugs; 5 lbs. 2-point L. S. leads; 1 8-inch composing stick; 1 8 by 12 ink stone; 1 font 6 point combination Gothic type; 1 font 18 point combination Gothic type; 1 font 12 point combination Gothic type; 2 fonts 2 point brass rule; 3 small cases two-thirds, size (for type); 1 lb. can quick-drying printer's ink.

* * *

In reporting the exhibits at the Philadelphia Commercial Congress, the "Philadelphia Record" mentioned several exhibits of iron articles which showed a beautiful dull black surface that was very attractive for such work. "Sparks" gives this explanation of the process as contained in the "Record":

It consists in coating the objects very uniformly with a thin layer of linseed oil varnish, and burning it off over a charcoal fire. During the deflagration the draught must be stopped. The varnish will first go up in smoke with a strong formation of soot, and finally burn up entirely. The process is repeated, i. e., after one coating is burned off a new one is applied, until the parts exhibit a uniformly handsome, deep black color. Next, wipe off the covering with a dry rag, and heat again, but only moderately. Finally the articles are taken from the fire and rubbed with a rag well saturated with linseed oil varnish. The black turns completely dull, and forms a durable covering for the objects.

* * *

The pressure exerted by a column of water is .434 pounds per square inch for each vertical foot of the column in height.

## SCREW PITCHES IN FOREIGN COUNTRIES.

### DATA UPON THE PITCHES OF SCREWS USED ABROAD AND THE GEARING FOR CUTTING THEM.

The various pitches of screw threads used in different parts of Europe, and even by different firms in the same country, have caused no little annoyance to makers of American machine tools who are manufacturing lathes for foreign shipment. To determine as far as possible what pitches these lathes are generally arranged to cut; whether the pitches are English or Metric units; and if the latter, whether metric lead screws are provided, or simply the usual screw, with translating gears for metric threads, we addressed letters of enquiry to a number of American firms, replies to which follow. We also publish replies from similar letters sent to a few foreign firms and engineers. To the fund of information thus accumulated is added a general review of the subject by Mr. Henry Harrison Suplee, the translator of Reuleaux's Constructor, whose extended study and experience render his opinion of exceptional value.

From Potter & Johnston Co., Pawtucket, R. I.:

"Our experience with the requirements of manufacturers in countries where the metric system is used would indicate that the use of two translating gears, with 50 and 127 teeth respectively, is entirely satisfactory and it is seldom that there is any call for lathes with metric lead screw."

From Fitchburg Machine Works, Fitchburg, Mass.:

"Our lathes for export have all been furnished with our regular lead screw and screw gears or with a metric lead screw and gears to cut metric thread. We have no demand for anything special beyond this."

From the Goddard Machine Co., Holyoke, Mass.:

"We have made no change in our lathes except to make them cut metric threads, which we do by adding two special compound gears to the regular outfit of the lathe. We furnish one each with 50 and 127 teeth. By far the larger part of the tools we export, however, are fitted to cut English threads."

From the F. E. Reed Co., Worcester, Mass.:

"We have orders from abroad for lathes, sometimes to cut American pitches and sometimes to cut metric pitches. When orders come for first named, we furnish simply our regular lathe. When the latter, we furnish our lathes with metric lead screw."

From the Brown & Sharpe Mfg. Co., Providence, R. I.:

"We would say that a common practice is to furnish an extra gear with 127 teeth (sometimes called a 'translating gear'), besides the regular set of change gears. This is based on the fact that 1 m/m = 5/127 of an inch almost exactly. By this method, if the lathe has a lead screw of one turn to the inch, gearing in the ratio of 5 to 127 would cut 1 m/m lead. If, however, the screw is not one turn to the inch, the gearing would be 5/127 × No. of turns per inch of lead screw, and if the thread to be cut is not one m/m lead, then the gearing would be 5/127 × No. of turns per inch of lead screw × the lead in m/m of screw to be cut.

SCREW CUTTING TABLE FOR 13" ENGINE LATHE FOR CUTTING METRIC THREADS.

| Pitch to be Cut. | Gear on Spindle. | First on Stud. | Second on Stud | Screw. |
|---|---|---|---|---|
| 1 mm. | 105 | 49 | 28 | 127 |
| 1.5 " | 105 | 49 | 42 | 127 |
| 2 " | 105 | 49 | 56 | 127 |
| 2.5 " | 105 | 49 | 70 | 127 |
| 3 " | 105 | 49 | 84 | 127 |
| 3.5 " | 105 | 49 | 98 | 127 |
| 4 " | 80 | 28 | 84 | 127 |
| 4.5 " | 105 | 28 | 72 | 127 |
| 5 " | 105 | 28 | 80 | 127 |
| 5.5 " | 105 | 28 | 88 | 127 |
| 6 " | 105 | 28 | 96 | 127 |
| 6.5 " | 105 | 28 | 104 | 127 |

"The blue print enclosed shows the gears required for ordinary pitches in m/m, which, as far as we know, are those commonly used abroad.

"This table is for lathes with lead screws of six threads, or turns to the inch, geared 1 to 2, giving a ratio of 1/12.

"Example: Required the gears to be cut 5 m/m lead.

$$\tfrac{5}{127} \times 12 \times 5 = \frac{300}{127} = \frac{105 \times 80}{28 \times 127},$$

the required gears as per table.

"When a metric lead screw is provided, the ordinary change gears can usually be used. For example, a 13" or 16" lathe geared 1 to 2 with a lead screw of 4 m/m lead requires a ratio of 1 to 2 between the spindle and the screw to give 1 m/m lead on the screw being cut, and the same gears can be used as for the lathe with the pitch of the screw in inches."

From the Hamilton Machine Tool Co., Hamilton, Ohio.:

"We would say briefly that we have no exact knowledge as to what proportion of European tool users demand metric as against English or vice-versa. Our practice, however, is to furnish metric lead screws whenever required, with the necessary index plate and gears to cut a reasonable number of threads; the pitch or lead of the screw being decided by its convenience and the number of change gears required. To illustrate—with our 18" lathe we have adopted a 6 mm. lead screw (6 mm. pitch means in this case lead per rotation of screw) and we furnish gears to cut 1 mm., 1 5, 2, 2.5 and so up to 7, 7.5, 8, 9, 10 and 12. Change gears required to cut the above are as per table annexed.

INDEX PLATE FOR 18" LATHE WITH ENGLISH SCREW

| Thread. | Stud. | Screw. |
|---|---|---|
| 2 | 48 | 24 |
| 3 | 48 | 36 |
| 4 | 48 | 48 |
| 5 | 48 | 60 |
| 6 | 48 | 72 |
| 7 | 48 | 84 |
| 8 | 24 | 48 |
| 9 | 24 | 54 |
| 10 | 24 | 60 |
| 11 | 24 | 66 |
| 11½ | 24 | 69 |
| 12 | 24 | 72 |
| 13 | 24 | 78 |
| 14 | 24 | 84 |
| 16 | 20 | 80 |
| 18 | 20 | 90 |
| 20 | 20 | 100 |

INDEX PLATE FOR 18" LATHE WITH METRIC SCREW.

| Pitch. | Stud. | Screw. |
|---|---|---|
| 1 mm. | 20 | 120 |
| 1.5 " | 20 | 80 |
| 2 " | 20 | 60 |
| 2.5 " | 30 | 72 |
| 3 " | 30 | 60 |
| 3.5 " | 35 | 60 |
| 4 " | 40 | 60 |
| 4.5 " | 45 | 60 |
| 5 " | 50 | 60 |
| 5.5 " | 55 | 60 |
| 6 " | 48 | 48 |
| 6.5 " | 52 | 48 |
| 7 " | 56 | 48 |
| 7.5 " | 45 | 36 |
| 8 " | 48 | 36 |
| 9 " | 45 | 30 |
| 10 " | 50 | 30 |
| 12 " | 60 | 30 |

"The majority of our lathes are fitted with English screws and indexed for English threads. When it is desired to cut metric threads with an English screw outfit, we furnish a simple compounding attachment and a 50 and 127 tooth change gear in addition to the regular set, when by compounding, the operator is enabled to cut metric screw threads, and the index plate used for English threads will then indicate the same number of threads per centimeter that it usually indicates in English threads per inch."

From the Pratt & Whitney Co., Hartford, Conn.:

"Our lathes can be arranged for cutting threads to the metric system by making the head and change-gear studs long enough to receive a double train of gears, adding translating gears of 50 and 127 teeth for one train and using regular change gears for the second train. By this means the same number of threads per centimeter as per inch, and finer and coarser threads may be cut, as well as a greater variety of feeds obtained than under the regular construction. A number of our foreign customers prefer a metric lead screw, and, of course, when this is furnished the above special gears are not required."

From the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio:

"In regard to the threads used abroad, on most of our lathes that go to Germany and all that go to England, we send the regular standard thread as used in this country. On most of the lathes that go to France and some that we send to Holland, Belgium, Switzerland, Austria and Russia, we send about one-half metric and half United States standard.

NO. 1. SCREW-CUTTING INDEX, METRIC SYSTEM, 12", 14", 16" AND 18" LATHES.

| Mm. Pitch. | Stud. | Screw. |
|---|---|---|
| .60 | 18 | 75 |
| .70 | 21 | " |
| .80 | 24 | " |
| .90 | 27 | " |
| 1. | 30 | " |
| 1.25 | 25 | 50 |
| 1.50 | 30 | " |
| 1.75 | 35 | " |
| 2. | 40 | " |
| 2.50 | 40 | 40 |
| 3. | 48 | " |
| 3.50 | 56 | " |
| 4. | 64 | " |
| 4.50 | 72 | " |
| 5. | 80 | " |
| 5.50 | 44 | 20 |
| 6. | 48 | " |
| 7. | 56 | " |
| 7.50 | 72 | 24 |
| 8. | 64 | 20 |
| 9. | 72 | " |
| 10. | 80 | " |

NO. 2. CHANGE GEAR LIST FOR CUTTING METRIC PITCHES ON 12" LATHES.

| Thr. Pitch in mm. | Stud. | Screw. |
|---|---|---|
| .7 | 24 | 71 |
| .8 | " | 62 |
| .9 | " | 56 |
| 1. | " | 50 |
| 1.25 | 30 | " |
| 1.50 | 36 | " |
| 1.75 | 42 | " |
| 2. | 48 | " |
| 2.50 | 60 | " |
| 3. | 72 | " |
| 3.50 | 42 | 25 |
| 4. | 48 | " |
| 4.50 | 54 | " |
| 5. | 60 | " |
| 6. | 72 | " |

"When we have a call for a metric pitch, we furnish our customer with a metric screw and special change gears cutting from .60 to 10 millimeter pitch as per table No. 1 enclosed herewith. However, we have had several calls for a lathe to cut both metric and U. S. standard thread. This we accomplish by furnishing an independent reverse plate and special gears which are figured out so that they come to within a limit m about .001 or .002 per inch either way. We do not use mpound of 127-50, but figure out the gears for each thread me as we would, for example, if we had to cut six threads 15/1000".

course, you understand the ratio between the two systems 127 is to 50. This, of course, cannot be reduced and as 127 make a very large gear, we have to take the closest thing n to this and then figure our other gears so that the dis- between the threads will be 1-2-3-4-5 millimeters, etc. required to cut both U. S. and metric threads we simply om .07 to 6 millimeter pitch as per table No. 2.

e have never had any complaint about our range and on gular metric lead screw we have taken the pitches that were ed at the International Congress at Zurich, 1897."

e pitches mentioned above as having been adopted at are the same as those contained in the regular "Systeme ais," commonly used in France, with the addition of two pitches to be used with diameters not included in the or- system. These pitches have been kindly furnished us by s. Hermann-Glaenzer & Co., Paris, and are printed below, er with the corresponding diameters, as far as we have ble to obtain them.—Editor.]

| ameter, imeters. | Pitch, Millimeters. | Diameter, Millimeters. | Pitch, Millimeters. |
|---|---|---|---|
| .. | .60 | 36 | 4. |
| .. | .70 | 42 | 4.50 |
| .. | .80 | 48 | 5. |
| .. | .90 | 56 | 5.50 |
| 6 | 1. | 64 | 6. |
| 8 | 1.25 | 72 | 6.50 |
| 10 | 1.50 | 80 | 7. |
| 12 | 1.75 | 88 | 7.50 |
| 14 | 2. | 96 | 8. |
| 18 | 2.50 | 116 | 9. |
| 24 | 3. | 136 | 10. |
| 30 | 3.50 | | |

m Lodge & Shipley Machine Tool Co., Cincinnati, O.:

e only special thread that we arrange our lathes to cut to the requirements of the European market is 19. We fur- our lathes with metric lead screws if so required, making ial lead screw for the machine."

m Th. Peters, Director of the Society of German Engin- Berlin:

answer to yours of the 14th inst., we beg to reply that it be advisable if the 'lead screw' on turning lathes used screws, for sale in Germany, were fitted out with a of ½" English measurement, as at present most of the Ger- machinery factories still use a screw based on the Whit- scale and the old English inch, and in the transition to the screw it is necessary to insert a gear wheel with 127 to make an English lead screw cut metric screws."

m DeFries & Co., Berlin and Wien, Germany:

swering your request, we enclose a schedule in which are particulars in regard to screws as commonly used here country. It is as follows:

SCHEDULE OF SCREWS

| DIAMETER OF SCREW. | | Pitch per Inch. | DIAMETER AT ROOT OF THREAD | |
|---|---|---|---|---|
| Inches. | Mm. | | In Inches, English. | Mm. |
| ¼ | 6.35 | 20 | 0.18 | 4.72 |
| 5/16 | 7.94 | 18 | 0.24 | 6.09 |
| ⅜ | 9.52 | 16 | 0.29 | 7.36 |
| 7/16 | 11.11 | 14 | 0.34 | 8.64 |
| ½ | 12.70 | 12 | 0.39 | 9.91 |
| ⅝ | 15 87 | 11 | 0.51 | 12.92 |
| ¾ | 19.05 | 10 | 0.62 | 15.74 |
| ⅞ | 22.22 | 9 | 0.73 | 18.54 |
| 1 | 25.40 | 8 | 0.84 | 21.33 |
| 1⅛ | 28.57 | 7 | 0.94 | 23.87 |
| 1¼ | 31.75 | 7 | 1.07 | 26.92 |
| 1⅜ | 34.92 | 6 | 1.16 | 29.46 |
| 1½ | 38.10 | 6 | 1.29 | 32.68 |
| 1⅝ | 41.27 | 5 | 1.37 | 35.28 |
| 1¾ | 44.45 | 5 | 1.49 | 37.84 |
| 1⅞ | 47.62 | 4½ | 1.59 | 40.38 |
| 2 | 50.82 | 4½ | 1.71 | 43.43 |
| 2¼ | 57.15 | 4 | 1.93 | 49.02 |
| 2½ | 63.50 | 4 | 2.18 | 55.37 |
| 2¾ | 69.85 | 3½ | 2.38 | 60.45 |
| 3 | 76.20 | 3½ | 2.63 | 66.80 |

## METRIC SCREW THREADS.

HENRY HARRISON SUPLEE.

iew of the extending use of American machinery in coun- n which the metric system is in general use there has been inquiry as to the best method of adapting screw-cutting to metric screw-thread systems. Nearly all such inquiries e that there exists in the metric system some standard sys- of screw threads such as the Sellers in America, or the Whitworth in England, and all that is needed is to procure standards and proceed to make taps and dies, and to equip lathes with appropriate lead screws and change-gears.

As a matter of fact there are so many different metric screw-thread systems that no standard really exists. The following list of so-called systems, which does not claim to be complete, will show that at least there is ample variety. Thus we have the systems of: Armengaud, Redtenbacher, Paris-Lyons-Mediterranean R. R., Northern Railway of France, J. F. Cail, the French Navy, two systems of Ducommun, the Engineering Society of Mulhouse, Reishauer & Bluntschli, Pfalz-Saarbruck, Society of German Engineers, two systems of Delisle, Reuleaux, and the Zurich International Congress. Each of these has been intended to supersede its predecessors, but it has been well said that it is much easier universally to adopt a new thing than it is universally to throw away an old one, and so each attempt to improve has only added one more to the confusion, and no permanent step toward a standard has been made.

These systems relate to threads for bolts, but as they extend for sizes up to 80 millimeters diameter, or more than 3 inches, it will be seen that they are intended to cover the great range of general shop work. For larger diameters, and for square or special threads, the profile and pitch are chosen by the designer, the sizes being expressed in millimeters and tenths.

There does not seem to be much consolation for the American maker of machine tools in all this, but as a matter of fact the metric-using nations have settled the thing very neatly themselves by using the English Whitworth standard in nearly every case, and paying no attention to any of the proposed metric systems. In the best shops of Switzerland and Germany, bolts and nuts are made with the dimensions in English inches and fractions thereof, and with the form and pitch of threads conforming to the Whitworth standard.

In regard to screw-cutting lathes, the problem of cutting metric threads can be solved in a very simple manner to a very close degree of approximation. As is well-known, there are almost exactly 25.4 millimeters in an inch, and so with a lead screw of one-inch pitch, and with change gears of 10 and 254 teeth, a screw of one millimeter pitch would be cut. As a matter of practice this is simply modified by making the lead-screw of half-inch pitch and the corresponding change gear of 127 teeth. The result is that a 10-tooth gear on the spindle will cut one millimeter pitch, an 11-tooth gear, 1.1 millimeter pitch; a 15-tooth gear, 1.5 millimeter pitch, and so on for every decimal of a millimeter. The precision of this method will be seen when it is understood that the error would amount to only 0.00008 of an inch in one meter, an amount which is quite within the limits of the precision of our knowledge of the true relation of the meter and the inch, and doubtless within the limits of accuracy of the lead screw of a commercial lathe.

Under these circumstances, therefore, there seems to be no good reason for agitation about the equipment of American lathes with metric lead screws, nor of any attempt to produce standard metric dies and taps. Standard Whitworth threads can readily be made on American tools by the use of commercial dies, and metric threads cut on American lathes by the addition of but one extra gear, and it is difficult to see how the situation could be simplified.

* * *

A course in "sugar engineering" is a new development at one of our progressive colleges. The college giving it, however, is neither Wellesley nor Vassar, as might be inferred. The students attending these two institutions are supposed to be so well versed in this branch that further instruction in it would be superfluous. The course is given at Tulane University, Lexington, Va., to fit students to take responsible charge of both the mechanical and chemical work connected with the sugar making industry. It is held that the mechanical engineers and chemists who have made more or less of a specialty of sugar making machinery and processes do not exactly satisfy the demand for an all-around man, who is familiar with both the mechanical and chemical sides of the industry, and who is capable of taking intelligent general direction of a sugar-making plant. It is primarily with the object of supplying this need and of offering a suitable training for the sons of sugar planters that this course has been planned.

# AN HOUR IN ONE OF THE OLDER SHOPS.

## NOVEL EXAMPLES OF DRILL FEEDS AND EPICYCLIC GEARING.

One of the older New England shops is that of the Humphrey Machine Co., Keene, N. H. The proprietor, Mr. J. Humphrey, has been closely identified with the water wheel industry of the country for many years and is a well-known authority upon the subject of hydraulics. His shop is not a large one, but the class of work that it has been called upon to do during a period of nearly 40 years has been so varied, both in size and kind, that could we describe the ways and means adopted to turn out the work, it would afford many a page of instructive reading. In most shops where jobbing is done, snags are encountered that tax both ingenuity and patience to the utmost; but couple with these snags the difficulties that had to be overcome in the days when no special tools were to be had, and but few sizes of lathes, planers and one or two other lines of standard tools were made, and it will be understood why so many of the older shops are interesting places for one to visit, if he appreciates ingenuity in machine work.

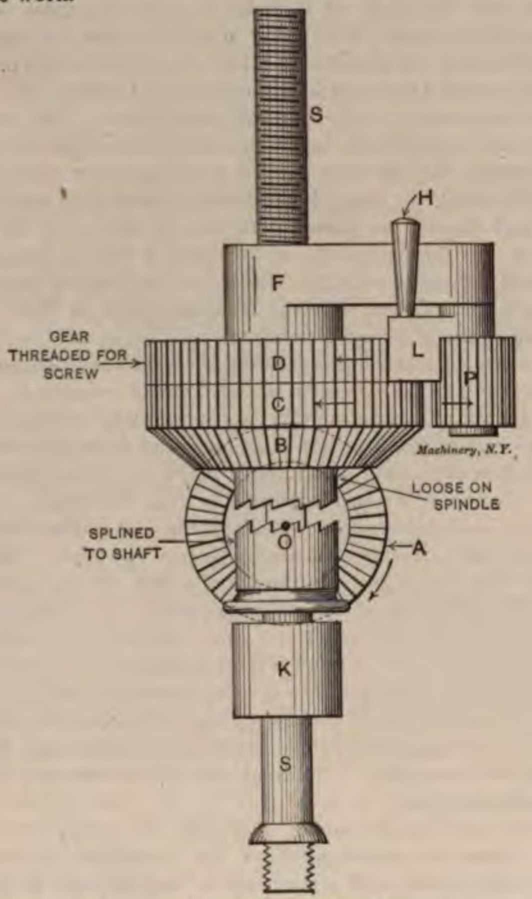


FIG. I. COMPACT FEED ARRANGEMENT.

In this shop, for example, is a boring mill that was built by Mr. Humphrey when boring mills could not be bought as readily as now, and probably if they could have been, there would not have been enough work for it to do to warrant the expenditure. This machine is nominally a "nine-foot" mill that, in its day, was the largest machine in the country around—and perhaps it is today—for this particular corner of New England has not been blessed with many machine industries. This boring mill has a wooden frame and is capable of being jacked up indefinitely, to take work of almost any capacity that may be required. In fact, the height and diameter of such work as it may be required to do appear to be immaterial. The machine has power feed, will bore and turn at any angle and altogether has seemed to be too useful an adjunct to the shop to be discarded.

For strict originality, however, the two drilling machines which are shown in outline in the accompanying sketches easily take precedence. Mr. Humphrey calls these machines "somewhat interesting as curiosities," but does not consider them very useful for general purposes or very creditable to their maker. In this regard we must beg to take issue with him, for although they were built in the early sixties, they possess features worthy of study, even by "20th century" designers.

The earlier drills that we occasionally see, while they have the power feed, generally lack the quick-return feature that is so essential to rapid work. The drills designed by Mr. Humphrey, however, not only have the quick-return, but one of them feeds through epicyclic gearing and the whole arrangement of both of them is novel.

In Fig. 1 is a small swivel drill that was intended to drill radial holes on the inside of the arc of a circle. Only the spindle and feed mechanism are shown, but the machine itself is bolted to a column in the shop and swivels about the point o, so that it will drill in any direction in one plane. F and K are bearings supporting the spindle S, the upper end of which is threaded. The spindle is driven through the medium of the bevel gears A and B and the clutch O, which is splined to the shaft. Gear B is loose on the spindle and can drive it only when the clutch is thrown in.

The feed is through gear C, which is in one piece with the bevel gear B, the gear D and pinion P, which latter acts as an idle gear. Gear D has one or two less teeth than gear C, although of the same diameter, and pinion P can be moved into contact with the two gears by rotating an eccentric bushing on which it runs. The hole in gears C and B is a free-running fit on the spindle, but the hole in D is threaded to accommodate the threaded part of the spindle. When the pinion P is moved into gear with C and D and the clutch is thrown in, the spindle rotates at the same speed as gear C; but gear D, having a less number of teeth than C and being driven from C through pinion P, rotates slightly faster than the spindle and wheel C, and therefore gradually screws the spindle downward.

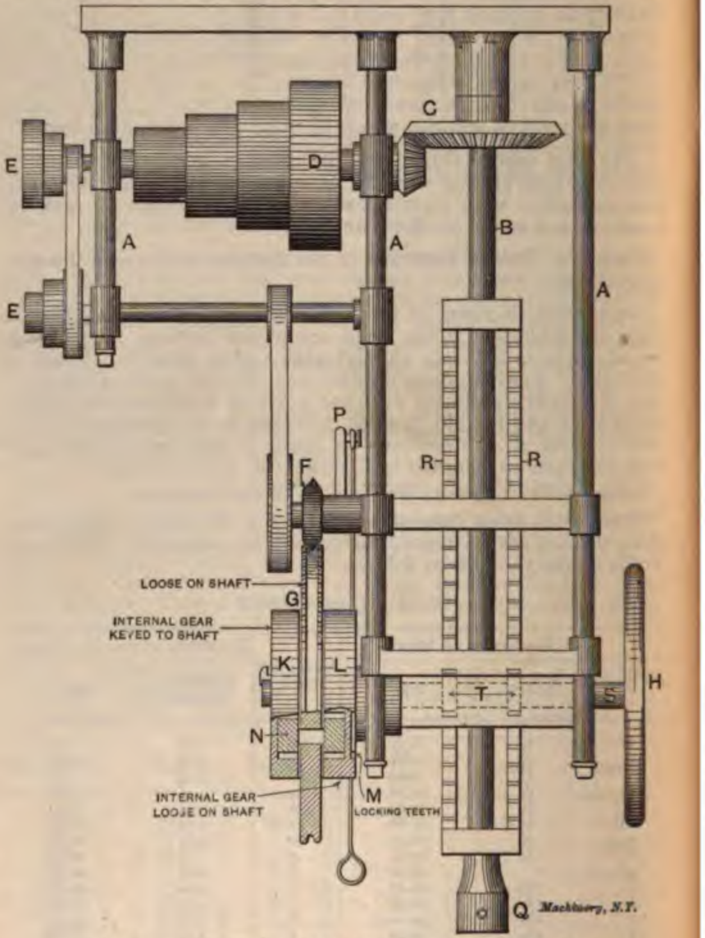


FIG. 2. SUSPENSION DRILL WITH EPICYCLIC FEED.

If it be desired to move the spindle downward more rapidly when getting the drill into position, the clutch is thrown out. This stops the rotation of the spindle, and D will then turn at a greatly augmented speed relative to the spindle and will screw it downward much faster.

For the quick return, pinion P is moved out of gear by the handle H, which also pushes the brake L against the teeth of gear D and keeps the latter from turning. The clutch is then slid into contact and the spindle is driven while D remains stationary as long as the brake is in contact. This makes the relative motion of the spindle and gear opposite to what it was before and the spindle is returned quickly to the desired position.

A good suspension drill is a useful machine and the one shown in Fig. 2 was pronounced by one of the men who has used it for several years as the best tool of the kind that he ever saw. That it has good features, we think our readers will admit. It not only has a power feed, but a quick return which can be operated much easier than those on some modern drill presses, where a square-jawed clutch must be moved in or out before the spindle can be returned. It also has either a rapid and sensitive hand feed, or a powerful and slow hand feed, as desired.

Referring to Fig. 2, the machine is suspended by six round rods, three of which are shown at A, A, A, and the various bearings, etc., for the shafts and spindles are supported by fittings attached to these rods.

The drill spindle is driven from the cone D through the bevels at C. B is the spindle, Q being the drill chuck. Moving with the spindle longitudinally, but not rotating with it, are two racks, R, R, into which gear the pinions T (shown dotted) upon the horizontal shaft S. When this shaft is free to be turned, the drill spindle can be moved up or down by the hand-wheel H, which gives the rapid movement to the spindle. As will shortly be explained, the spindle can also be moved by the grooved wheel G, which resembles hand wheel H in form, when a slow, powerful hand feed is desired. The upper end of the spindle passes through the floor from which the drill is suspended.

The power feed is through the cones E, E, thence by belt to the friction wheel F, which runs in frictional contact with the large grooved wheel shown at G. This wheel is loose on the horizontal shaft S and carries two pinions, fast to one spindle, as shown in section at N. Each of these pinions runs in an internal gear, one of which appears at the left of the large wheel at K and the other at the right at L. Of these internal gears, the one at the left is keyed to the shaft and the one at the right is loose on the shaft, but has a series of notches, M, at the rear by which it can be locked in position through a suitable clutch mechanism, not shown. One of the internal gears has a greater number of teeth than the other and hence, when L is locked stationary by the clutch at M, the whole system constitutes a train of epicylic gearing. At P is a lever which operates an eccentric sleeve by which F can be raised or lowered into contact with G. When it is lowered into contact, wheel G carries pinions N in the circumference of a circle about the axis of shaft S and causes the internal gear K to turn slowly, its speed depending upon the relative number of teeth in K and L.

To illustrate the use of the drill, suppose it to be suspended from the ceiling where large castings can be easily moved into position underneath. The spindle is lowered into position by the handwheel H, when the power feed is thrown in by the clutch at M. After having nearly completed the hole, if it be desired to finish by hand, the friction wheel F is moved out of contact and then the spindle will have a powerful hand feed, the operator using the friction wheel G as a handwheel instead of H. After the drill has broken through, the operator throws out the clutch at M and returns the spindle by the wheel H.

There are a number of other interesting machines in this shop that are novel, but as the writer's visit was for only about an hour, time did not permit copious notes and it should be understood that the sketches that have been given illustrate the principle, merely, and not the actual details of construction. Of the other machines, one is a bevel gear planer that was rigged up about 15 years ago to do a special job when the Corliss planer had three months' work ahead. Not caring to wait so long, some parts of old machines lying around the shop were picked up, with which a gear planer was evolved that cost not over 50 dollars all told. The machine answered well enough for the work and at prices charged by others paid at the rate of 60 cents an hour on the first job. Although the machine has since been relegated to the store house, it has occasionally been found serviceable for odd jobs. It is an excellent example of the ability of the true mechanic and engineer to accomplish results, even when the means at hand are not very promising. It affords a lesson that the young mechanic of to-day, who has everything to do with or done for him, may well heed.

* * *

When making calculations, do not retain the fractions or decimals unless the degree of accuracy that their use implies is actually attained.

## GEAR SHAPER IMPROVEMENTS.

In the January, 1898, number of MACHINERY was published a detailed description of the Fellows gear shaper which embodied radically new principles for a gear-cutting machine. The teeth of gears are cut in this machine by a planing tool, instead of a milling cutter, and the tool that is used is nothing more nor less than an accurately-formed gear wheel of tool steel, having the sides and faces of the teeth so shaped as to form cutting edges, like the edges of a planer tool. This cutter, besides having a reciprocating motion across the face of the gear blank to be cut, revolves in harmony with the blank, just as a gear wheel and pinion would revolve when their teeth are in contact, and correctly-shaped teeth are gradually formed around the whole circumference of the blank. Only one cutter is required for gears of the same pitch of any size, and the principle of the machine is based on the fact that a gear tooth can be made to form its conjugate in a blank running in correct relations with the tooth. This is an old principle, but it has been worked out in a very modern way in this machine.

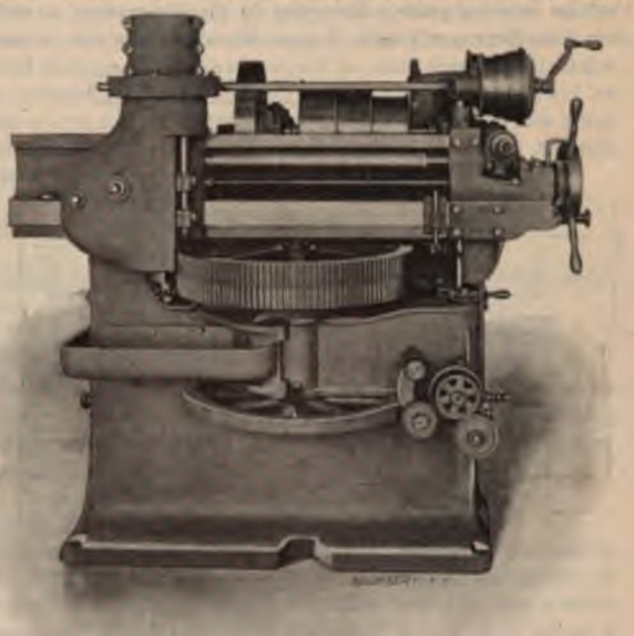


FIG. 1. 36-INCH GEAR SHAPER CUTTING TWO 24-INCH GEARS.

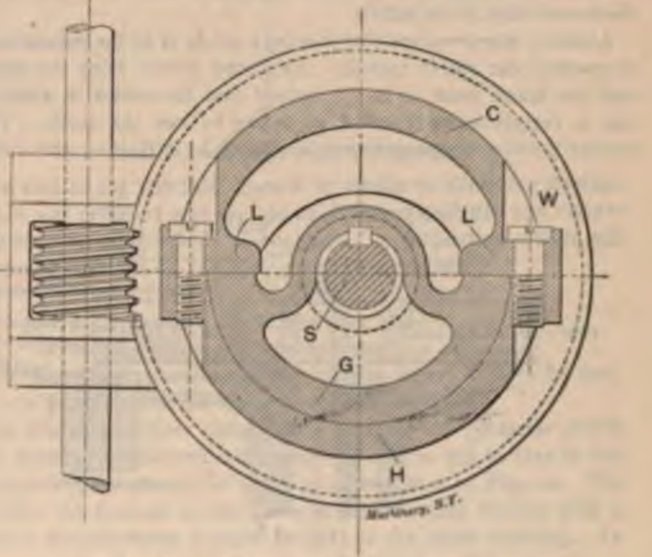


FIG. 2. INDEXING DEVICE FOR CUTTER SPINDLE.

By comparing the illustration of the Fellows gear shaper which we show herewith with that in the number of the paper referred to, it will be observed that several essential changes have been made in the design of the machine, as suggested by the experience gained with the original design during the past two years. It has been desirable to cut coarser pitches than was originally intended and this requires cutters of larger diameter than were formerly used. To accomplish the heavier work successfully, it is quite essential that the ram carrying the cutter be supported, if possible, the entire length of the stroke. The ordinary design, with overhanging ram, will not do. Also, an ordinary slide, large enough to support the cutter for most of its travel, would be excessively heavy. The problem was finally solved by giving the ram a circular form somewhat larger than the diameter of the largest cutter, allowing the cutter to follow the ram into its guide. Referring to the illustration, it will be seen that there are a pair of gear blanks in position, with the cutter operating upon them. Above these blanks are the ways, or the cross-rail upon which slides the saddle carrying the cutter bar or ram. This ram is vertical and its lower end, with the cutter, can be seen at the left, projecting a short distance below the lower edge of the saddle.

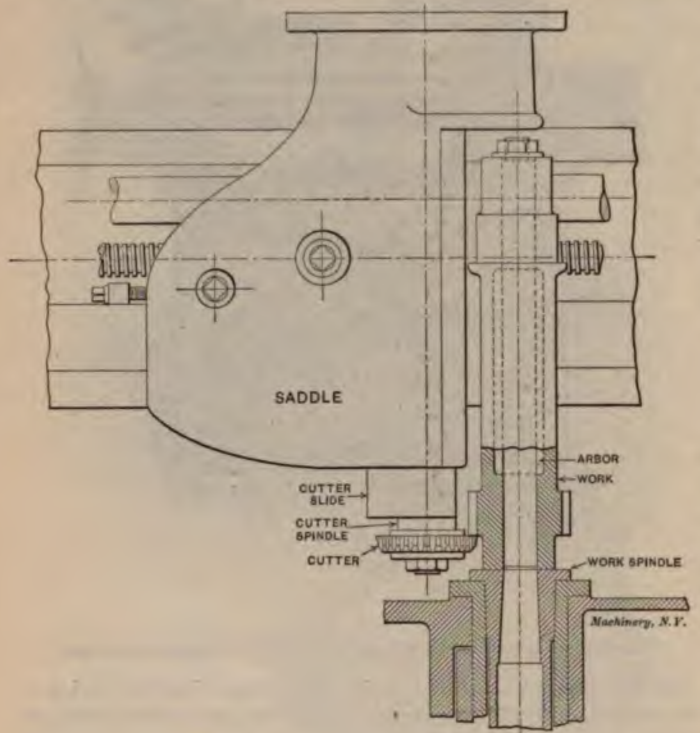


FIG 3. CUTTING BACK GEAR PINION.

Another improvement that has been made is in the means used to control the cutter spindle. As stated above, both the cutter and the blank must rotate in unison and the cutter in addition has a reciprocating motion in order to cut the teeth. This double motion of the cutter is arranged by attaching the cutter to a spindle which passes vertically through the center of the ram and reciprocates with it, but which is free to turn inside of the ram so as to give the cutter the proper rotary motion. The latter motion is obtained through the medium of a worm and worm-wheel and the improvement consists in arranging the sliding connection between the worm-wheel and the cutter spindle so that there will be no backlash between the two, even after long wear. The way the problem is worked out is shown in Fig. 2. The cutter spindle extends above the cutter ram and a section at this point is shown in this figure. S is the cutter spindle and to it is keyed securely a piece of the shape shown at G, which moves up and down with the spindle. W is the worm-wheel, which has a long hub H extending upward for some distance. One-half of this hub is cut away and to it is bolted a cap, C, which has lugs L, L, extending inward and bearing on two flat surfaces of the guide G. Now, as the worm-wheel revolves, motion is transmitted to the spindle through its hub and the guide G, and, at the same time, the spindle and its guide are free to slide inside of this hub, and the sliding surfaces are at so great a distance from the center of the spindle, and are so well proportioned, that they are very durable. Moreover, after long wear any lost motion can be taken up by means of the cap.

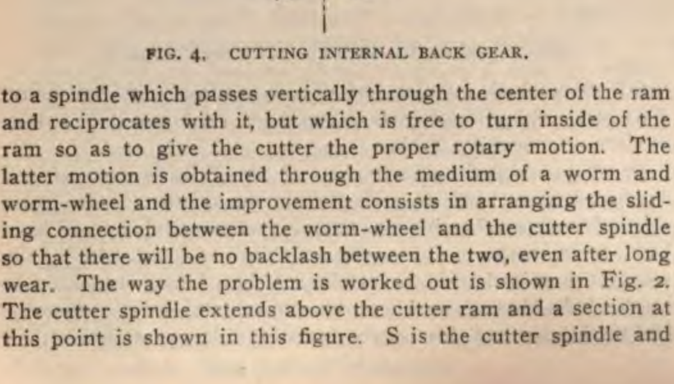


FIG. 4. CUTTING INTERNAL BACK GEAR.

It will be noted from the photograph that the saddle has most of its bearing for the ram on the right side of the cutter, removed to give room to cut pinions with long hubs or quills. Fig. 3 shows the method of cutting the back gear quill of a lathe head and in Fig. 4 is an illustration of a method of cutting internal gears, work for which this machine is particularly adapted. The gear shown is the back-gear used on the Fellows gear shaper, which has an internal and an external gear on one hub. This gear is cut at one setting by the same cutter, the position of the cutter for the external gear being indicated by the dotted lines.

* * *

## A FLOATING MACHINE SHOP.

The accompanying illustration is taken from a photograph of a floating machine shop. This shop is not intended to be a rival of the repair shop Vulcan, which as far as we know, is the first and only shop that was designed for exclusive use while afloat. The natural home of the shop shown is upon dry land, and it is merely in the process of transportation from one point to another. It is a section of the shop of H. Bickford, Lakeport, N. H., who make a specialty of the manufacture of boring and turning mills, which are known to many readers of this paper.

MOVING DAY AT LAKEPORT, N. H.

The building is 120x40 feet, and as it was desired to move it, the novel method was adopted of floating it upon barges. Three barges were used with two tug boats, one on each side, and the whole building was moved with everything intact at a cost of less than $500. An account was recently published of the moving of a building upon railroad cars, and Mr. Bickford writes us that he believes that method was no more novel than the one adopted by himself. The photograph for the illustration was kindly furnished by Mr. Bickford, and is reproduced herewith.

* * *

### THE LOST FOUND.

"Ice and Refrigeration" says that a Kentucky scientist claims "to have discovered the lost art of tempering copper by means of intense cold." When steel is tempered and hardened it is first heated and softened and then plunged into cold water. This man, however, claims that copper is affected in just the opposite way. When placed in the intense cold and chilled to a temperature of 312 degrees by liquid air, he says that it is softened, and that if it be then withdrawn and thrust into a heated furnace it will be hardened and tempered. And so it seems that the ancients are supposed to have known all about liquid air or some other substance approaching absolute zero temperature! Shades of Tripler, what next?

# GAS ENGINE DESIGN.—3.

## DIRECTIONS FOR CALCULATING DIMENSIONS AFTER THE MAIN PROPORTIONS HAVE BEEN DETERMINED.

E. W. Roberts.

Having determined the cylinder diameter, the stroke, the volume of the compression space and the speed at which the engine is to run, the designer has a foundation upon which to base the remaining dimensions of the engine. It is well to make the bulk of the computations before starting the drawing, and I will proceed to show the methods for determining the minor dimensions of the engine. Many of these dimensions are based upon the diameter of the cylinder. In fact this method of design is often overdrawn and it will, in some cases, give dimensions quite out of proportion to the requirements of the part. There are, however, quite a number of dimensions that may be based upon the cylinder diameter without leading the designer into serious errors.

A very important matter and one that is quite frequently overlooked by the average gas engine designer is the proportioning of the inlet and the exhaust passages. They are too often made smaller than requisite for the efficient working of the engine. A good rule, and one that is followed by the most successful designers is, to limit the speed of the gases in the inlet passage to 100 feet per second and those in the exhaust passages to 85 feet per second. For illustration take a 10x15 engine running at 220 r. p. m. The piston speed would then be

$$\frac{2 \times 15 \times 220}{12} = 550 \text{ feet per minute.}$$

The area of the piston is 78.54 square inches. At 100 feet per second the speed of the gases in the inlet passages would be 6,000 feet per minute. The areas of the cylinder and the inlet would then be inversely proportional to the speeds of the gases in each. The area of the inlet passage would then be

$$\frac{550}{6{,}000} \times 78.54 = 7.2$$

or a circular passage 3.03 diameter, say a three-inch pipe.

For the exhaust passages the speed would be 5,100 feet per minute, and the area of this passage would be

$$\frac{550}{5{,}100} \times 78.54 = 8.46 \text{ square inches,}$$

or a circular passage 3.2 inches diameter, say a three and one-half inch pipe.

The general formulas for the above calculations would then be

$$\frac{S}{6{,}000} A = a \text{ for the inlet, (9)}$$

$$\frac{S}{5{,}100} A = a^1 \text{ for the exhaust, (10)}$$

Wherein

$S$ = speed of piston in feet per minute.
$A$ = area of cylinder.
$a$ = area of the inlet passages.
$a^1$ = area of the exhaust passages.

For a speed of 600 feet per minute these formulas resolve themselves into the following:

$.1A = a$ (9a)
$.12A = a^1$ (10a)

As these passages are for the most part of circular cross-section, the latter formulas may be still further modified and based directly upon the diameters of the cylinder and the passages.

Thus

$.316D = d$ (9b)
$.35D = d^1$ (10b)

Wherein

$D$ = the diameter of the cylinder.
$d$ = the diameter of the inlet passages.
$d^1$ = the diameter of the exhaust passages,

these two formulas being, like the preceding, applicable only when the piston speed of the engine is 600 feet per minute.

It is not always practical to make the valve openings themselves as large as the above formulas call for. Particularly is this true when the valves are placed in the cylinder head of the engine. It is advisable, however, to make them as nearly as possible to the above dimensions and the writer would advise against making them less than 75% of the dimensions indicated by the formulas, otherwise there is apt to be wire drawing, which will show to a marked degree on the indicator diagram.

The thickness of the cylinder walls is dependent not only upon the requirements for resistance to bursting but also those of rigidity, wear and reboring when the cylinder gets out of true. On the basis of 4,000 lbs. safe stress for cast iron and 300 lbs. maximum pressure in the cylinder, the thickness of the wall for resistance to bursting would be .0375 times the diameter of the cylinder for the same safe stress; and on 500 lbs. maximum pressure, the thickness of the walls would be .0625 times the diameter of the cylinder. Practice among gas engine designers gives an average of .09 times the cylinder diameter, a figure which gives ample allowance for all factors. Hence the following formula represents average practice in this respect:

$t = .09D$ (11)

Wherein $t$ = thickness of the cylinder wall.
$D$ = the diameter of the cylinder as before.

Average practice gives for the depth of the water jacket measured on a radius of the cylinder across the water space,

$j = .1D$ (12)

Wherein $j$ = the depth of the water jacket.

For the thickness of the outer wall surrounding the water space, there appears to be no rule which is followed even closely by gas engine designers, and the writer has adopted the following for engines of his own design:

$w = .045D$ (13)

Wherein $w$ = the thickness of the jacket wall.

This latter ratio will be seen to be just one-half of that given for the cylinder wall, a proportion which makes it convenient to remember. For very small engines these formulas give dimensions that are scarcely large enough, and it is well to adopt a minimum thickness for the cylinder wall of 5-16 inch, for the water space ⅜ inch, and for the jacket wall 3-16 inch. Otherwise it will be found difficult to get the best castings.

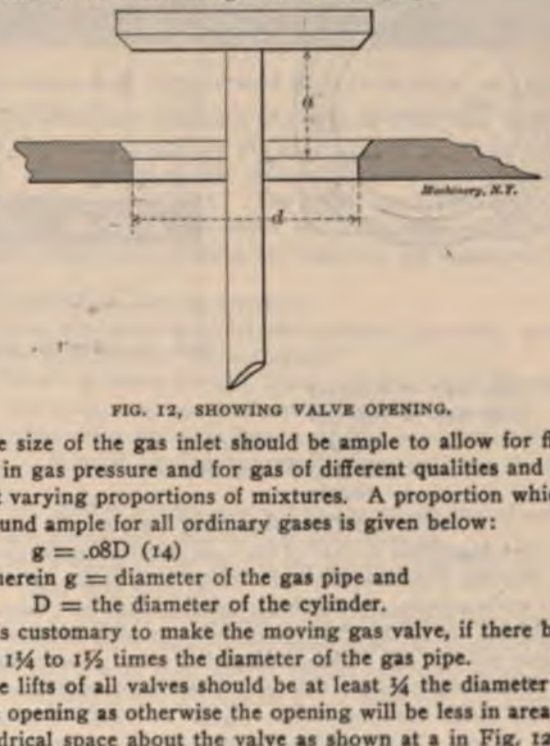


FIG. 12, SHOWING VALVE OPENING.

The size of the gas inlet should be ample to allow for fluctuations in gas pressure and for gas of different qualities and consequent varying proportions of mixtures. A proportion which will be found ample for all ordinary gases is given below:

$g = .08D$ (14)

Wherein $g$ = diameter of the gas pipe and
$D$ = the diameter of the cylinder.

It is customary to make the moving gas valve, if there be one, from 1¼ to 1½ times the diameter of the gas pipe.

The lifts of all valves should be at least ¼ the diameter of the valve opening as otherwise the opening will be less in area in the cylindrical space about the valve as shown at a in Fig. 12. The space for the passage of the gases is a cylindrical surface with a height a and diameter d equal to that of the valve opening. In order to make the area the same as that of the valve opening, a must be of such a height that the area of this surface, which is found by the formula area = $\pi$ da, shall be equal to the area of the valve opening. And since the area of the valve opening is equal to

$$\frac{\pi d^2}{4}$$

the value of a may be found by equating these two quantities and cancelling, whereby the result becomes

$$a = \frac{d}{4}$$

The diameters of the inlet and the outlet pipes for the jacket water should be made about 15% of the cylinder diameter, taking the pipe which is nearest that given by this rule, and always giving the benefit of the doubt to the next larger size.

There has now been given sufficient data for the design of the cylinder, an example of which is shown in Fig. 13. It is customary to build cylinders for all engines except the very smallest —six horse power and below—separate from the frame of the engine. The style of cylinder shown in the figure is that employed on vertical engines and it is bolted to the frame by means of the flange as shown. This flange may be made square or circular according to the fancy of the designer, the square form shown in the figure being better adapted to an oblong frame such as is employed for two or more cylinders. The writer has taken as an example a cylinder for a 12"x18" engine. Suppose that the pressure which it is desired to obtain after compression is 80 lbs. per square inch, and that the entire clearance is included in the cylinder by so designing the engine that the valves are contained in the cylinder-head and open directly into the cylinder. The absolute pressure will then be $80 + 14.7 = 94.7$ lbs. after compression, and the clearance is found by means of formula (1). Taking the total volume of the cylinder as equal to one, for the sake of convenience, and finding the volume of the compression space as a per cent. of the whole $D = 94.7$ and $K = 14.7$ and V is equal to

$$\sqrt[1.3]{\frac{14.7}{94.7}}$$

In order to solve this equation it is necessary to resort to logarithms as already shown. First finding the logarithm of the fraction.

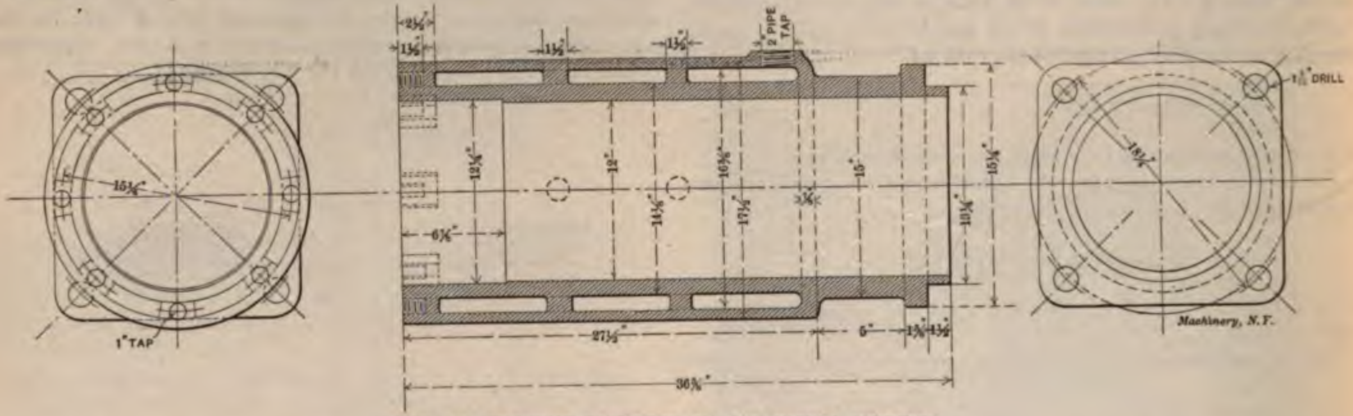


FIG. 13, SHOWING DIAMETER OF GAS ENGINE CYLINDER.

Log. 14.7 = 1.167317
Log. 94.7 = 1.976350
$\bar{1}.190967$ Subtracting
1.3).809033 Subtracting from 1.
.622333
$\bar{1}.377667$ Subtracting from 1.

This last logarithm is that of the compression space, remembering that the total cylinder volume has been taken as 1. The number corresponding to this logarithm is a little less than .2382 Three figures are all that it is necessary to employ and the quantity taken will be .238. The compression space should then be 23.8% of the total cylinder volume. The volume swept over by the piston would then be 100% — 23.8% or 76.2% of the total cylinder volume. If the added diameter given to the compression space by the counter-bore be not considered, the length of the cylinder required for the compression space would be $23.8 \div 76.2 = 31.3\%$ of the piston displacement. The length of the compression space would then be $18 \times .313 = 5.634$ or 5⅝ long.*

Should it be desired to carry this computation to the refinement of allowing for the counter-bore, it will be necessary to find the volume displaced by the piston. This volume is

$(12)^2 \times .7854 \times 18 = 2030$ cu. in.

$2030 \times .313 = 640$ cu. in. volume of compression space.

The area of the compression space, allowing ¼ inch for counterboring, is

$(12.25)^2 \times .7854 = 118$ sq. in.

$640 \div 118 = 5.45$ say 5½ inches.

The length of the compression space is thus shown to be ⅛ less than that found by the approximate method. The piston should extend far enough into the counter-bore to allow, on an engine of this size, about ¼ inch over travel of the piston.

The sizes of the cylinder-head studs should be calculated for a pressure at least sixty pounds above the usual maximum pressure in the cylinder, to allow for sudden strains which are occasionally thrown upon the engine by very rich mixtures. The maximum pressure at the beginning of the expansion stroke is the compression pressure multiplied by 4 or $80 \times 4 = 320$ lbs. Adding 60 lbs. to this amount, the pressure upon which to base the calculations of the studs is 380 lbs. and the total pressure is the latter amount multiplied by the area of the counter-bore or $380 \times 118 = 45{,}000$ lbs. Dividing this among eight studs, the tension upon each stud would be $45{,}000 \div 8 = 5{,}650$ lbs., and allowing a tension of 10,000 lbs. per square inch as a safe stress for mild steel, the area of each stud should be $5{,}650 \div 10{,}000 = .565$ square inches at the root of the thread. The corresponding diameter is .85 inches, and from a table of screw threads it will be found that the stud having a diameter next larger than .85 is 1⅛, but that the 1 inch has a diameter at the root of .837 or within a little over 1% of the required size. The 1 inch stud will therefore be used.

In regard to the number of studs, it is usual to have no less than six, and a good rule to follow is to use enough so that they will not be over six inches apart. In the case of the cylinder under consideration, six studs would have placed them too far apart. The stud circle should be placed at the center of the water-jacket and this will give the diameter of the stud circle as 14⅛ + 1⅛ = 15¼. The circumference of the circle is 47.9 inches and eight studs brings the distance apart just within the limit.

The thickness of the cylinder wall, the depth of the jacket and the thickness of the jacket wall are calculated by the formulas given above and are as follows:

Cylinder wall (formula 11) = $12 \times .09 = 1.08$, say 1 1-6 inches.

Depth of jacket (formula 12) = $12 \times .1 = 1.2$, say 1⅛ inches.

Thickness of jacket wall (formula 13) = $12 \times .045 = .54$ inches, say 9-16 inches.

The four bolts which are used to bolt the cylinder to the frame are subject to the same tensile stress as the cylinder studs. The strain on each bolt is therefore $45{,}000 \div 4 = 11{,}250$. The bolts may be made of mild steel and the area of each would therefore be 1.125 square inches and the diameter at the root of the thread should be 1.2 inches. The table shows that the bolt required is 1½ inches, the 1⅜ inch bolt being a little too small. The thickness of the flange should be equal to, or slightly greater than, the diameter of the bolt. In the present instance it is made 1⅝ inches thick.

The length of the projection below the flange for centering the cylinder in the frame should be about ⅛ the diameter of the cylinder and is 1½ inches in this case. The total length of the cylinder is the sum of the following distances:

Projection of the piston head into the cylinder, 1 inch.
Length of the compression space, 5½ inches.
Stroke of the engine, 18 inches.
Length of the piston minus the over-run, 12 inches.
Total length of cylinder, 36½ inches.

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* In the above, and in all future calculations in this series, the writer will employ the slide rule. Hence any slight discrepancies discovered will be due to the limitations of that instrument.

The piston should be 1 1-3 times as long as the diameter and ¼ of its length may be allowed to over-run the cylinder at the end of the forward stroke.

The water-jacket should extend about 10% of the stroke beyond the end of the piston when the crank is at the outward dead center. In this cylinder the jacket is allowed to extend 2 inches beyond the end of the piston travel. The length is therefore 26½ inches from the end of the cylinder. Other dimensions of the cylinder are shown in the figure.

The size of the water inlet is obtained from the rule already given. It is 12 × .15 = 1.8, say 2" pipe. It should be placed so that the bottom of the pipe is as near as practical to the bottom of the jacket.

* * *

## JONES ENGINEERING CO., LIMITED.

### CHAPTER 6.—MR. JONES TRIES TO BABBITT AN ENGINE BEARING.

You know that a good handle is a rather difficult job to turn up and get a pattern which will look well and feel well; and having made one, it is quite difficult to turn another exactly like it; indeed, it is sometimes given to a new man as a test job, and in fact it was Jones' favorite test. He tried it on a young man who started in to work the other day, telling him to turn up such a handle as he would think suitable for a machine which was under way. The young fellow did a fairly good job, but he displayed it with such a superior air that the old man thought it necessary to give him a little lesson, "lest he forget," as Kipling would say. He examined the handle carefully and finally directed him to make another just the same length, but a little bit larger, and in order to show him the proportions of a perfect handle, Jones set the calipers himself. On comparing these with the handle which he had just finished, the new hand discovered that the "little bit larger" was only 1-16 of an inch, and he concluded that no man, let alone Jones, could be so discriminating as to judge, by the unaided eye, within this limit; so instead of making a new handle to match the calipers, he closed up the calipers to match the old handle and passed them both in for inspection. "There," said the boss, "that's better; that's about right; don't you think yourself that it's a great improvement?"

Now, if the smart young Aleck had said "yes" he would have been all right, but he tried to turn the laugh on Jones by giving the whole job away, thinking that the old man would join in and laugh with the rest. He was mistaken; if any laughing was to be done the young chap must do it himself. "Here, you, I'll teach you to make fun of me to my face; now you take these calipers and calip every durn handle in this shop and you just keep caliping until I tell you to quit." The young man argued that he wasn't hired to be snubbed like that. "Yes, you be, you're hired to do as I tell you, and you be a doin' of it." The young man started in with what grace he could, trying his calipers on everything within reach, the old man watching him out of the corner of his eye until he was called away, as you will presently be told. The young man, concluding that he had all the fun he wanted, put on his coat and started off "down country" after another job.

Across the river from Jones was a mill where he was often called to conduct repairs. One afternoon he heard some one shouting to him from over "yonder," so he rushed to the back door and heard the engineer calling out: "Hullo-o-o Jones, put on your boots and come o-o-over here!" As the fellow seemed to be in trouble, Jones lost no time in getting there. He found that while the engineer and fireman had been fishing for suckers in the river, the belt had come off the regulator, allowing the engine to race to beat Nancy Hanks. Now, according to all precedent, the fly-wheel should have exploded and killed some inoffensive person and finally have been picked up in the next county, but it did nothing of the sort. It ran faster and faster until the bearings became dry and the shaft became polished as though it was buffed and finally the babbitt melted and ran down on the floor. When Jones arrived he found the engineer rigging up a chain hoist to take the shaft out from the boxes. He had "been there before," but Jones assured him that there was no need of taking it down, he could do the babbitting with the shaft in place.

"Hadn't the babbitt ought to be hammered and bored out," asked the engineer.

"No, I've got some babbitt that an agent sold me the last time he was round, said it was already hammered and as for boring out, if we leave the shaft right in there and pour the babbitt around it we shall get a better bearing than any boring out would give."

So Jones went back after his "Pre-hammered Babbitt Metal," which the crafty agent had sold him at a dollar a pound, but which looked to others like a lot of old lead. He melted the metal carefully and poured it into the bearings, using plenty of "rosum" to make it flow freely and fill well. It did both, it flowed freely and it filled the cavity, apparently, in good shape. The engineer and fireman looked on with some interest. If the operation was successful they were learning something; if not, they had an unpleasant all night's job in prospect to take the shaft out and babbit the boxes in the orthodox way. After the melted metal had set and a few pails of water had been poured over the boxes to reduce the expansion of the shaft due to the heat, Jones picked up his ladles and directed the engineer "to start her up, easy at first." The steam was turned on, but nothing started; a little more steam was given, but she did not move.

"KNOCK SOME INTELLIGENCE INTO YOUR HEAD, MR. JONES."

"You must have stopped her right on the dead center," said Jones.

"Didn't either—see for yourself."

"Then you must have let the pressure go down, guess you have been fishing for suckers again."

"There's pressure enough, same as usual," said the engineer, who had become somewhat distrustful of the operation.

"Throw off your main belt, probably every machine in the shop is shipped on and you can't expect to start them all at once."

"You needn't trouble yourself to throw off any of our belts, we have always been able to start with them on."

"Take a hammer and rap on the boxes, guess they jest stick a little 'cause they are new."

"Take a hammer and knock some intelligence into your head, Mr. Jones. The trouble is you have gone and soldered the shaft to the boxes with your patent babbitt and your rosin and your dum foolishness and I'd like to know what you are going to do about it."

Well, there was nothing that could be done about it; the shaft had become so heated and run so dry that not a particle of oil remained upon it, and the babbitt metal, aided, perhaps, by the rosin, had clung to it so firmly as to hold it in place. Just how they ever got it free I can only guess, but it was without the help of our friend, Jones, who returned to his shop with drooping spirits. The story soon got around and everybody was soon laughing at his numerous "bulls," until he finally sold his shop and left town. He, too, wandered off "down country," and going into a shop in search of employment, the first person whom he saw was the young man who had turned the handle in Jones' old shop.

"Hullo, Aleck," said Jones. "What be you doin' here."

"Calipering handles," said the young man with a grin, holding up a pair of calipers. "You told me to keep at it until you ordered me to quit."

W. H. S.

## BUSHING A LOCOMOTIVE CYLINDER.

Owing to the generally unfavorable conditions under which a locomotive performs its work, the wear and tear of all parts of the machinery is much greater than on the mechanism of a stationary engine for the same length of time. This statement is particularly true of the valves and cylinders. The dust and cinders drawn into the cylinder cocks when "drifting" and the often insufficient lubrication of these parts which follows the narrow-minded policy in the management of many railroads, demanding a maximum of mileage for a minimum of oil consumption, causes the cylinders to wear rapidly, and they frequently require reboring with a mileage of 150,000 miles or less. It therefore follows that a few years of service finds a locomotive over-cylindered or with cylinder diameters bored out to such a diameter that the tractive force of the locomotive due to its weight is not sufficient to balance the pressure on the pistons and excessive slipping follows when such an engine is starting a train. Besides this trouble, there is also the danger of rupture from the internal pressure on the walls of the cylinders which have become excessively thin from the wear and frequent re-borings.

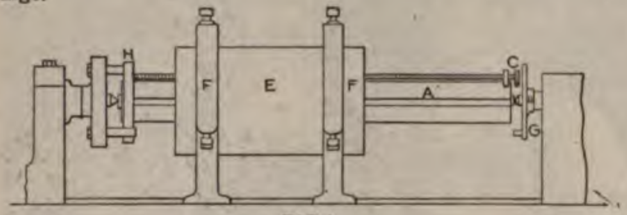
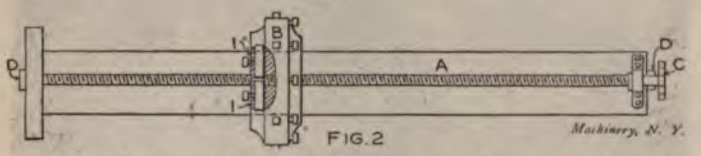


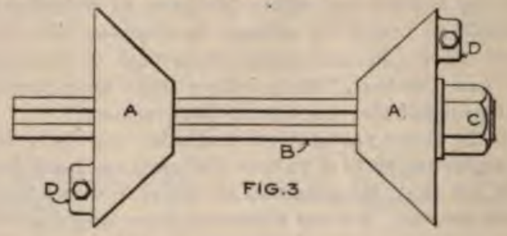
FIG. 1



When this condition of the cylinders of a locomotive has been reached, it is quite common practice in many locomotive repair shops to bush the cylinders, or, in other words, to insert a thin liner in them which reduces the diameter to the normal size and gives them a new lease of life. Although the operation of bushing a locomotive cylinder is simple, it is, however, interesting and will bear a general description, as there are some kinks in the operation that are the result of practical experience.

The casting that is to be a cylinder bushing is made in the form of a hollow cylinder having a wall thickness of about 1½" for a 20" cylinder and a length of perhaps 4" greater than that required between the heads. The cylinder is bored out for the bushing before the latter is turned and the bushing is generally bored before being turned. The boring is usually accomplished in the smaller repair shops on a lathe rigged for the purpose. Fig. 1 shows the general arrangement of a lathe for this work which was used in the Fallbrook Railway shops at Corning, N. Y., and the following described operation is the one followed in this shop. As will be noted, the bushing E is held in two huge steady-rests or chucks F F, which in this instance were provided with three adjusting screws each, for holding and centering the bushing with the axis of the lathe. The boring-bar used for boring bushings and new cylinders is shown in Fig. 2, which shows the cast-iron bar at A to which is splined the boring-head with multiple cutters at B. The feed-screw with its star-wheel is shown at C and the split nut for the feed-screw at I I. The bar A was made, as stated, of cast-iron which gives great stiffness, and it was provided with steel centers D D which gave better wearing results than would have been obtained from the cast iron bar with plain centers. After the bushing was bored, the ends were beveled out with a cutter in the boring head so that the bushing would center itself accurately on the mandrel shown in Fig. 3. This mandrel, as will be seen from a glance at the cut, has two tapered parts A A which are split at one side and provided with a clamp screw across the division line so that the two cones can be firmly gripped to the bar B. In addition the bar B is provided with a keyway in which feathers in the parts A A engage. The nut at C is for forcing the right cone to the left and thus clamping the bushing between the two opposing cones. To drive the bushing when turning it down to the proper diameter, it was found best to drill and tap a hole in the bushing for a stud H Fig. 4, and drive from that point instead of attempting to drive from the mandrel, as when this was done it was necessary to clamp the bushing so tightly that it was likely to be sprung out of shape and even when clamped as securely as possible would sometimes slip and cause trouble.

After the bushing was turned to the proper size, which must be enough larger than the diameter of the cylinder to give it a shrink fit, it was cut nearly, but not quite in two, with a parting tool, as shown at Fig. 4, and then the ports were drilled and chipped out so that they would correspond to those already in the cylinder. When boring the cylinder a shoulder is left near the back head against which the bushing will abut when in position, and when cutting off the bushing in the lathe it is left long enough to project slightly from the face of the joint so that it can be finished down flush when shrunk in place. When the bushing is ready for insertion, the cylinder is heated to expand its diameter to a size sufficient to admit the bushing freely and to do this without danger of getting caught, it is usually warmed up enough to enlarge the diameter from 1-32" to 1-16" greater than that of the bushing. This is necessary on account of the rapid cooling of the cylinder with a consequent reduction of its diameter and an accompanying heating of the bushing and consequent increase in its diameter. So it is evident that any little delay at a critical point may result in a very awkward predicament and one not well calculated to increase the prestige of a machinist who is so unfortunate as to become "stuck" when engineering such a job. The cylinder is sometimes warmed to the required temperature by a light wood fire built in the bore, but as this makes a dirty job and requires the most scrupulous nicety in cleaning out the debris after the heat is taken and at a time when moments are precious, the Bunsen gas burner shown in Fig. 5 can be made and used with great success, as it requires so little gas for the heating of a cylinder that the cost is trivial, and being perfectly clean in its action no time is lost in cleaning out any debris after the removal of the heater.



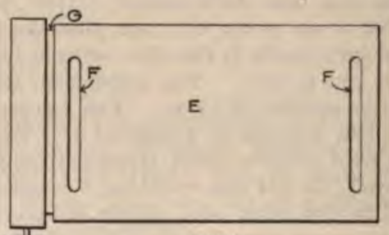
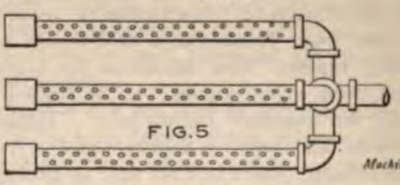


FIG. 4



Machinery, N. Y.

To facilitate the insertion of the bushing, its surface is well smeared with a coating of white lead and oil which acts as a lubricant while entering it and afterwards fills up the interstices between the bore of the cylinder and the bushing so that any leakage will be effectually shut off. When putting the bushing into the cylinder, the ring that projects and which is nearly cut off, is found to be very convenient and necessary for obtaining the proper location of the bushing so that the ports shall register with those in the cylinder. By slipping a monkey-wrench on to the projecting part, the bushing can be readily turned to its proper position, which would be a rather awkward proceeding to accomplish without a projecting part. After the bushing is in place, it is drawn firmly against the shoulder at the further end by a long bolt and cross pieces across the mouth of the bushing, and by leaving it under these conditions until cool, the bushing cannot draw away from its abutment at the farther end. After the now unnecessary ring is knocked off and the end finished off flush with the cylinder, the job is complete providing the lathesman has counterbored the bushing to the correct dimensions. If this has been neglected, it must be done when the boring bar is in position for facing off the joint.

In some quarters, the bushing of locomotive cylinders has fallen from favor not because it is not a good mechanical expedient, but from the fact that it is often necessary to reduce the cylinder diameter slightly below the nominal diameter in order to use a bushing having walls thick enough to be of any practical value. This occurs only on locomotives having cylinders with thin walls to begin with, but the "kick" that comes from the freight engineers when a locomotive gets new tires and has the cylinders bushed in such cases, is one that does not increase the master mechanic's peace of mind. With an increased driver diameter and a reduced piston area, the starting power of a locomotive may be greatly reduced, and, although possibly far more economical in fuel and water consumption, the practical disadvantages overbalance any gains that may result from economy or cheapness of general repairs. It has in consequence been found to be better though more expensive practice under these conditions to replace worn cylinders with new ones of full diameter than to bush old ones down to a slightly smaller size.

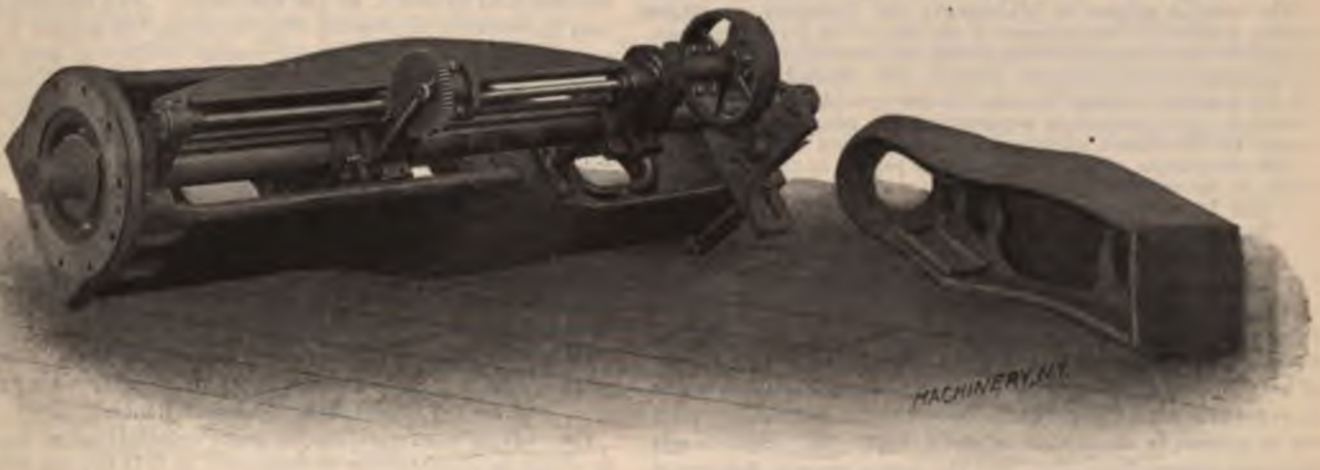
* * *

## BORING RIG FOR ENGINE FRAMES.

Charles Fosdick.

This cut shows a very effective device for boring the guides for cross-head shoes upon a girder engine frame. The centering bar is held by a "cat-head" at the cylinder end of the casting and by a U-angle iron and step at the off-set end and remains in place until the machining of the casting is fully accomplished, with the exception of the drilling. The bar has centers in its ends for use in the lathe and is used as an arbor to face both ends of the casting.

After the facing is completed and before removing the arbor or bar from the casting, the boring head is attached. This head is constructed in halves to clamp around the bar, and while it produces what may rightly be called "bored guides," it is in reality a "planing head" rather than a "boring head." There are two cutters, one for the upper and one for the lower guide, fastened to opposite sides of a sleeve, which reciprocates in the arc of a circle about the axis of the bar. This sleeve, instead of having its bearing directly on the bar, bears on another sleeve which is feathered to a slot in the bar so that it can slide but not turn upon it, and thus the wear upon the bar is reduced to that of the mere sliding of this bushing upon the bar as the cutter head advances.



BORING RIG FOR ENGINE FRAMES. SHOWN IN POSITION.

Reciprocation of the cutter head rather than rotation is desired in order that the central rib of the engine frame may be as near the center line of the guides as possible, thus increasing the stiffness of the guides. Only enough clearance for the passage of the crosshead is allowed.

As stated, the cutter head is provided with two cutting tools, one for each guide surface. These tools are made adjustable for boring the right diameter and are readily set by calipering from the cut to the bar surface. The reciprocation of the cutter head is obtained by a short connecting rod between a pin on the cutter head and a pin in the face of the driver. This driver has a gear-tooth rim and is carried in a bearing on the standard which forms the sleeve for the cutter head to move upon and which, as we have before said, moves forward as the cut advances. This driver engages with a pinion feathered to a shaft, plainly shown in the engraving, the pinion being carried forward with the cut by the standard, which also makes a central support for the shaft. At one end of the shaft is a gear which again engages with a pinion on one end of a short shaft, which carries at its other end a belt driver pulley as shown. By this back-gearing a powerful cutting force is given to the cutters and roughing out is done quickly and easily. The feed or forward motion of the standard and cutter head is obtained by a threaded feed rod lying so as to just clear the cutter head. This rod has a ratchet wheel feathered to it, which is connected to a nut in the standard.

The ratchet is operated by an eccentric and strap on the back side of the driver gear. By changing the position of the pin in the driver gear the stroke of the cutting tools can be set to agree with the diameter of the surface of the guides and the width of the guide faces.

This boring and facing rig forms a stiff arrangement, and as the work of facing the frame and boring the guides is done at one setting of the bar, the work should come true. It is another of the practical devices which are so common in American shops for accomplishing simply and correctly a needed result. This tool has been used for many years by the Fitchburg Steam Engine Co. in their shops at Fitchburg, Mass.

* * *

In view of the discussion among engineers as to the material and design for the cables for the new Brooklyn bridge it is interesting to recall that Col. Roebling, the chief engineer of the bridge, decided, after nearly six years of experimenting with steel wire of foreign as well as American production, that neither open hearth nor Bessemer steel could be made which would come up to the requirements he thought it necessary to demand for the cable wire. As originally drawn his specifications excluded steel made by these processes, and carefully stipulated that crucible cast steel should alone be used. A more mature consideration of this stipulation when the subject came up for final discussion before the Board, however, reversed his opinion. At the present time the cheaper grades of steel have been so perfected that there is no doubt as to their quality.

* * *

A good scheme to follow in cross-sectioning tracings is described by a writer in the "Mechanic Arts Magazine" who says that he never sections the original drawing accurately but merely indicates the sectioning roughly. After the tracing is ready for sectioning, he slips a piece of cross-section paper which is ruled about 1-16" apart, under the tracing paper and traces the required sectioning. If the sectioning is to be fine, every line is traced; but if coarse, only alternate lines are traced, or every third line for very coarse work.

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# MACHINERY

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The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

| | |
|---|---|
| THE IRON AGE, about | 7,000 |
| THE AMERICAN MACHINIST, about | 12,000 |
| MACHINERY | 20,500 |

A prominent manufacturer of machine tools in Great Britain expresses the opinion that the present period of unexampled world-wide business activity is rather unfavorable to the forming of an opinion as to the ultimate results of American competition as regards machine tools and engineering in general, as users are at present in many cases glad to supply their requirements from any respectable source, and the former prompt delivery of American tools is not now to be relied upon. He considers the real tug of war will come when things quiet down to a normal level, but as that time seems, as yet, far distant, such changes may in the meantime be brought about on both sides the Atlantic, which may materially alter the present complexion of affairs.

* * *

## GIVING VS. WITHHOLDING INFORMATION.

When a manufacturer buys a machine, he almost invariably does so upon the advice of some person connected with his firm who is acquainted with shop methods and is competent to render an opinion as to its merits. Before expressing a preference for any particular machine, such a man wants to know about its details of construction and he will make it a point to find out about these, by some method or other, if he can. If, in addition, he knows something about the methods and care used in its manufacture, and is favorably impressed with them, the more likely will he be to recommend the machine, other things being equal.

One of the most important objects of a technical paper is to publish just the kind of information that a man in this position, who is responsible for the purchase of machinery, desires to obtain. Such information is valuable alike to the mechanic, who is interested in all that is new in machine construction, to the manufacturer who wishes to disseminate knowledge about his products and to the buyer who is anxious to learn as much as possible about that for which he is to spend his money.

In attempting to gather this information, however, one meets with views, concerning the advantages or disadvantages to the manufacturer of allowing information to go out for publication, that are as different as black is from white. Some firms, who are building modern machinery by modern methods, object very strongly to the publication of matter that they say will be for the benefit of their competitors and the point is raised that the development of their methods has cost them both time and money and they believe they are better entitled to the results of this experience than any one else.

On the other hand, other modern firms, who are building just as good machinery as those first mentioned, and by just as good methods, court the utmost publicity through the press and give every opportunity, not only to illustrate details of the machinery that they are building, but to describe the methods by which their products are turned out. They, in their turn, state that they consider the publication of such information as an excellent educator for the public with regard to the work they are doing, and that the more interesting such information is made and the more complete it is, the better the advertisement for them.

Here, then, as in many other departments of life and work, we have two contrary views, emanating from similar sources and both given as the judgment of men who base their judgment on years of experience. Both opinions cannot be right and without attempting to decide how great an element of error there may be in either or both, it can be said with justice, that, as far as we are able to determine, those who adopt what we may call the "open" policy are just as successful as those who do not. If the open policy is actually detrimental, it evidently does not seriously handicap the firms who have adopted it.

That many concerns are greatly annoyed by their competitors copying their products, we are well aware. This thieving is not only continually in progress here at home, but abroad as well, and it is likely to increase among foreign builders in their efforts to meet American competition. The copying is done, however, not from newspaper articles, but from the machines themselves. If a firm determines to copy the machine of another, a machine will be bought in the open market, or at least examined, opportunity for which is offered as soon as the machine is placed on sale.

Trouble from copying comes mainly from reproducing features of machines that are regularly manufactured rather than from the adoption of their methods of manufacture. There are too many good mechanics employed in the different shops, and too many tools of all descriptions for turning out all kinds of work, to make it worth while to attempt to copy methods, except, possibly, in some few or unusual instances.

Our advice is to give just as much information to the public about the construction of machinery as it is felt can be given without absolute injury to the business of the manufacturer. This supposed injury should be brought down to a dollar and cent basis—the same basis by which any department of business is estimated—and if it is believed that an injury will be realized that will show itself in decreased profits, there is nothing more to be said. Often times, however, we are suspicious that the injury may be more imaginary than real and that the real change in profits comes in the way of an increase to him who adopts the "open" policy.

* * *

While the making of small tools is not profitable when their cost is compared with the regularly manufactured lines, there are not many machinists but have a few tools of their own make and the apprentice who does not early evince a disposition to make some tools for himself, is not usually adapted to his chosen vocation.

# ESTING THE STRENGTH OF MATERIALS—1.

## TENSION AND TRANSVERSE TESTS.

EDW. F. MILLER.

The different mechanical tests commonly applied to determine e strength and elasticity of the materials used in construction e the following: Tension tests, compression tests, transverse sts, torsion tests, impact tests and repeated stress tests. A ecimen may be subjected to one or more of these tests. As ısion tests are the most common, this class of testing will be nsidered first.

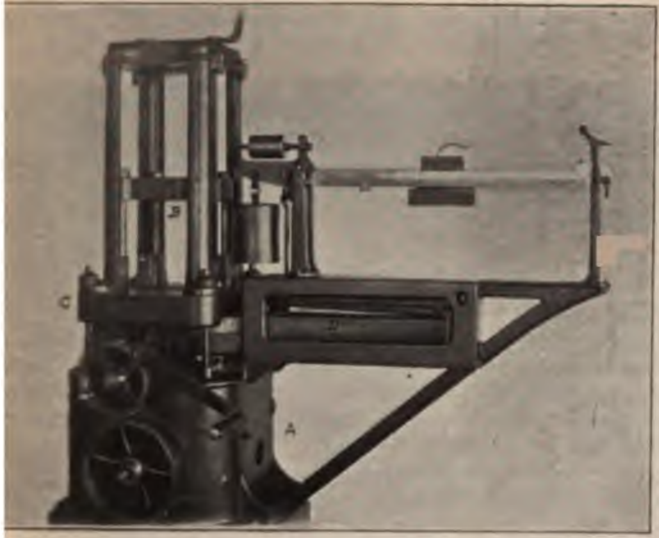

FIG 1. OLSEN TESTING MACHINE.

A simple lever testing machine is shown by Fig. 1. It conts of a hollow base A, in which a number of bevel gears are ınected so as to turn four spur gears which act as nuts on r splined screws. These screws pass up through the platform the machine and fasten to the pulling head B. Outside of se screws there are four cast-iron uprights fastened to the tform but entirely free of the screws. These uprights hold the top a casting similar to that fastened to the four pulling ews. The platform C rests on four knife edges fastened in cast-iron levers marked D. The fixed fulcrum of these ers is carried on the top of the casting A which forms the e. The outer ends of these two levers rest on a knife edge ıg from a second lever which in turn connects with the scale n where the load is weighed. The lever system and scales practically the same as in the common form of platform es used by grocers. Each of the castings, fastened one to screws and the other to the uprights, has a rectangular hole ugh the center. The narrow sides of this hole are inclined ut ½ an inch in a length of 4 inches. Two wedges of hardd cast steel fit into this opening. The wedges are roughened their inner faces in order to grip the specimen.

et us suppose that a piece of steel boiler plate 1.3333″ wide, o″ thick and 18″ long is put into the machine and gripped by wedges. On turning the hand wheel E so as to draw the ws down, a load is put on the specimen. The load on the imen produces an equal downward load on the uprights ch, in turn, carry the load to the platform where it may be weighed on the scale beam. To measure the amount the specimen stretches, two clamps, as shown by Fig. 2,* are fastened to the piece of boiler plate 8″ apart. A micrometer having a prick punch mark in one end and an extension piece screwed into the other end is used to measure the extension on two opposite sides of the specimen. As the stretch will be determined by the difference of readings, it is of no importance if the two sides of the clamps holding the measuring points are not exactly the same distance apart.

Suppose that 500 pounds load is put on the specimen and the readings of the micrometer for the two sides are noted; similarly 4,500 and so on, as shown by the logsheet of the test which follows:

TENSION TEST.

No. ...... Date, Nov. 1, '99.
Specimen, Steel Boiler Plate.

| LOADS. | | MICROMETER READINGS. | | Mean of Columns 3 and 4. | Difference of Means. | Stretch of Specimen per inch. | Stretch per inch per 500 lbs. Load. |
|---|---|---|---|---|---|---|---|
| Actual. | Per sq. in. | North Side. | South Side. | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 0 | ...... | .3402 | .3114 | .3258 | ..... | ...... | ...... |
| 500 | 1000 | .3404 | .3116 | .3260 | .0002 | .00003 | .00003 |
| 4500 | 9000 | .3425 | .3137 | .3281 | .0021 | .00026 | .00003 |
| 8500 | 17000 | .3447 | .3159 | .3303 | .0022 | .00027 | .00003 |
| 12500 | 25000 | .3468 | .3180 | .3324 | .0021 | .00026 | .00003 |
| 14500 | 29000 | .3480 | .3190 | .3335 | .0011 | .00014 | .00003 |
| 15000 | 30000 | .3482 | .3192 | .3337 | .0002 | .00003 | .00003 |
| 15500 | 31000 | .3485 | .3195 | .3340 | .0003 | .00004 | .00004 |
| 16000 | 32000 | .3489 | .3197 | .3343 | .0003 | .00004 | .00004 |
| 16500 | 33000 | .3492 | .3200 | .3346 | .0003 | .00004 | .00004 |
| 17000 | 34000 | .3497 | .3205 | .3351 | .0005 | .00006 | .00006 |
| 17500 | 35000 | .3506 | .3214 | .3360 | .0009 | .00011 | .00011 |
| 18000 | 36000 | .3520 | .3228 | .3374 | .0014 | .00017 | .00017 |
| 28500 | 57000 | Maximum | load on | specimen. | | | |

| | |
|---|---|
| Length between clamps.................... | 8″ |
| Dimension of cross section................ | 1.3333×.3750″ |
| Elastic limit ................................ | 16,500″ |
| Maximum load ............................ | 28,500″ |
| Dimensions of fractured section.......... | .95×.20″ |
| Ultimate extension in 8 inches............. | 2.24″ |
| Elastic elongation for 12,000 lbs. load equals ................................ | .0064″ |
| Area of original section; sq. ins........... | .5000″ |
| Elastic limit; lbs. per sq. in................ | 33,000″ |
| Maximum load; lbs. per sq. in. orig. sect.. | 57,000″ |
| Area of fractured sect.; sq. in............. | .1900″ |
| Reduction of area of cross sect.; per cent. | 62.0″ |
| Ultimate extension; per cent. of 8 in...... | 28.0″ |
| Modulus of elasticity ...................... | 30,000,000″ |

Column 8 of the log sheet gives the stretch per inch for each 500 lbs. increase of load. The amount or rate of this stretch is nearly constant till the interval is reached between 16,500 and 17,000 lbs. load, when the rate of stretch for 500 lbs. suddenly increases and continues to increase with the succeeding loads. The load per square inch at which the rate of stretch first changes is called the elastic limit. In this case, the load on the scale beam at the beginning of the change was 16,500 lbs., and as the area of the cross section of the specimen is 1.3333×.3750=.5000 square inches, the elastic limit is 33,000 lbs. per square inch. If the amounts of total stretch were plotted graphically we should get a line like Fig. 3 called the stretch diagram. The point marked A is the elastic limit and a point marked B a little farther to the right is called the stretch limit.

It is difficult to determine the true elastic limit without the aid or use of delicate measuring apparatus reliable to less than

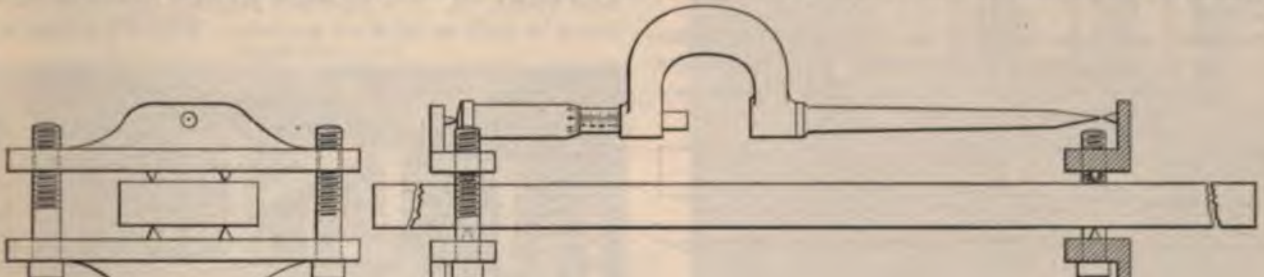

FIG. 2. CLAMPS AND MICROMETER FOR MEASURING STRETCH.

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* These are shown in a horizontal instead of a vertical position, such as they would have in the machine.

.0002 of an inch. The stretch limit is a little higher than the elastic limit and as it can be found much easier and quicker than the latter, it is often given as the elastic limit. If the scale beam is balanced with loads on the specimens and allowed to remain under load for a minute or two, it will be found that, up to a point in the immediate vicinity of the elastic limit, the scale beam will still be balanced at the end of the time. On passing a trifle beyond the elastic limit it will be impossible to keep the scale beam floating unless the loading screws are drawn down continuously. The point where the specimen would not hold the load balanced is the stretch limit. A point somewhere near the elastic limit, between the elastic limit and the stretch limit, may be found by counting the number of teeth the hand wheel cog advances in putting on successive 1,000 lb. loads. If the specimen does not slip in the holders, the number of teeth will be about the same for each load till after the elastic limit is passed when the number increases rapidly.

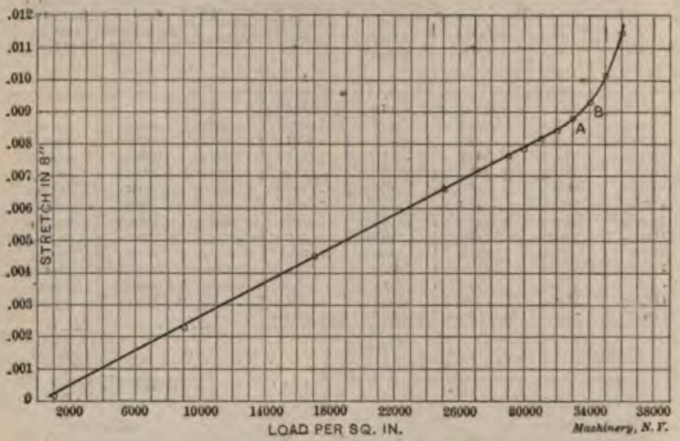


FIG. 3. STRETCH CURVE.

On many testing machines the stretch diagram is drawn by the machine. A measuring device arranged to multiply the stretch of the specimen many times records on a paper drum moved to correspond with the load shown on the scale beam. The diagram is then interpreted as explained. After passing the elastic limit, the measuring clamps are removed from the specimen and the maximum load which can be put on the piece is noted. The maximum load is reached in the case of iron and mild steel some time before the specimen fails. After passing the maximum load, the specimen pulls down rapidly, behaving much as molasses candy would, and finally fractures as shown by the cut Fig. 4.

The ultimate stretch is found by putting the broken pieces together and measuring the distance between the points where the measuring clamps gripped the specimen. This distance cannot be measured closer than 1-100 of an inch. In this case the distance was 10.24″, giving 2.24″ or 28% of stretch in 8 inches. The dimensions of the fractured section are taken and the reduction in area figured. The fractured section as measured was .95×20″ giving an area of .190 square inches. The reduction is .500—.190=.310÷.5 gives 62% as the reduction.

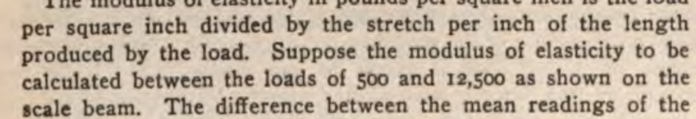


FIG. 4. BROKEN SPECIMEN.

The modulus of elasticity in pounds per square inch is the load per square inch divided by the stretch per inch of the length produced by the load. Suppose the modulus of elasticity to be calculated between the loads of 500 and 12,500 as shown on the scale beam. The difference between the mean readings of the micrometer at these loads is .0064″ as the stretch in 8″ or .0008″ per inch for an increase in load of 12,000 lbs. on the scale beam. As the original section of the boiler steel was 5″ area, this corresponds to an increase of load of 24,000 lbs. per square inch 24,000÷.0008=30,000,000, the modulus of elasticity. The modulus of elasticity is calculated with loads under the elastic limit. A small initial load is commonly taken as the starting load. This ensures the gripping of the wedges, and all the levers of the machine are brought to a bearing..

When the testing machine shown by Fig. 1 is to be used for comparison work, the hole in the pulling head is filled by a hardened steel disc, so arranged that it can swivel a trifle to allow for any lack of parallelism in the two bearing surfaces of the specimen.

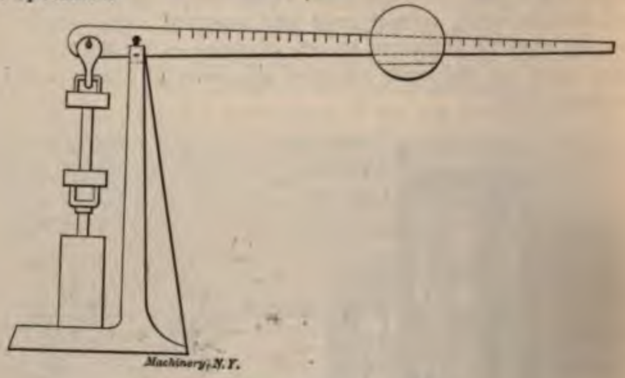


FIG. 5. SIMPLE LEVER MACHINE.

The piece to be tested is placed between the pulling head and the platform. There are many different forms of testing machines. Those which are accurate are arranged to weigh the push or pull transmitted through the specimen. In some inaccurate machines the load is applied by a hydraulic cylinder and figured from the pressure and the area of the piston. The piston or packing friction is variable and may amount to more than 25 per cent. of the calculated load; hence the amount of load on the specimen cannot be told.

A simple form of lever machine used to quite an extent in England is shown by the sketch, Fig. 5. There is a hydraulic cylinder for applying the load to one end of the specimen and a single lever with heavy poise weight, often 2,000 lbs., for weighing the load at the other end of the specimen.

In the laboratory of the Massachusetts Institute of Technology is a 300,000 pound Emery testing machine for both tension and compression tests. This machine has so many interesting features that the Editor has asked for a more extended description than was originally intended. As this can best be given in a separate article, the description will be deferred until the other subjects of the series have been completed.

### Transverse Tests.

By means of transverse tests we determine the strength and stiffness of timber beams, trusses, iron girders and I beams, cement beams, etc. It is especially desirable that transverse tests should be made on full-sized specimens. Most of the large testing machines for this class of work are "home made." Figs. 6 and 7 illustrate a large transverse testing machine used in the engineering laboratory at the Massachusetts Institute of Technology. It is of 100,000 lbs. capacity, and will test a specimen up to 26 feet span.

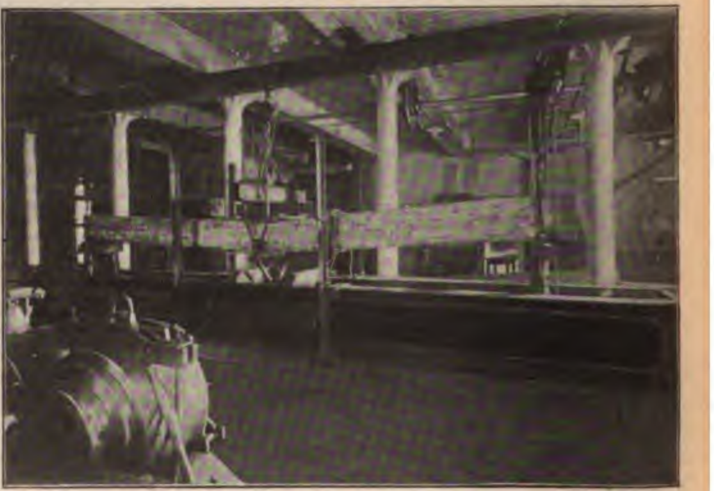


FIG. 6. FRONT VIEW OF LARGE TRANSVERSE TESTING MACHINE.

The machine is quite simple. Two steel girders rest at the center on a framework raised 4″ above the floor. These girders support two movable carriages which hold the jack-screws used for applying the load. At the center of the machine there are three levers used in weighing the load. Two of these levers are beneath the girders of the machine, and do not show in the cut. The main lever gives a multiplication of 10 to 1. It is of steel, about 6 ft. long, and at the larger end it is 13" deep and 2¼" thick. A steel yoke put over the specimen fastens to the lever system. The load is applied by raising the jacks at the ends of the specimen, and it is weighed through the pull exerted on the levers by the yoke attached to the center of the specimen. The steel girders forming the bed must carry, without undue fiber stress, the maximum load which the machine can exert.

Figs. 6 and 7 show a white pine beam which had been in service at least 75 years. The stick is 15" deep and 15⅞" wide. The span was 20 ft. In the test made on this beam in the testing machine the load was applied at two points, one foot either side of the center. The manner of distributing the load is shown by the I beams at the center of the machine. The deflection of the beam was measured in the following way: On either side of the beam a fine steel wire was stretched over pins driven into the beam directly above the supports and at the center of the depth. A ten-pound weight on the end of each wire kept the wire in tension.

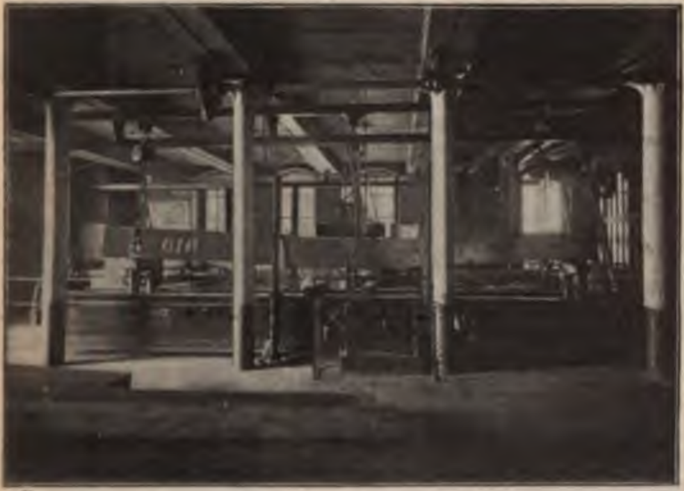


FIG. 7. BACK VIEW OF LARGE TRANSVERSE TESTING MACHINE.

A micrometer was fastened to each side of the beam at the center of the length and depth of the specimen. The face of the micrometer screws was set parallel with the wires, the screws being perpendicular.

TRANSVERSE TEST.

No. 616. Date, October 21, 1899.

Specimen—White pine beam taken from an old market on State Street, Boston. Specimen at least 75 years old.

| Loads. | Micrometer Readings. | | | | Mean. | Differences. | Remarks. |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 1 | 2 | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 1,000 | .0156 | .0155 | .0210 | .0212 | .0183 | .... | This specimen was hand-hewed. It was perfectly dry.<br>The failure was by a tension break. |
| 6,000 | .2260 | .2260 | .2419 | .2419 | .2340 | .2157 | |
| 11,000 | .4452 | .4452 | .4702 | .4704 | .4578 | 2238 | |
| 16,000 | .6575 | .6575 | .6920 | .6918 | .6747 | .2169 | |
| 21,000 | .8760 | .8762 | .9130 | .9132 | .8946 | .2199 | |

Manner of loading—At two points 12" either side of center.

| | |
|---|---|
| Span | 20 feet. |
| Dimensions | 15" deep, 15⅞" wide |
| Weight of yoke, &c. | 727 lbs. |
| Weight of beam | 953 lbs. |
| Maximum load by scales | 63,975 lbs. |
| Maximum load on beam (including yoke, but not including weight of beam) | 64,702 lbs. |
| Deflection from 1,000 lbs to 21,000 lbs. load | .8763" |
| Modulus of rupture (including weight of beam) | 5917 lbs. |
| Modulus of elasticity between 1,000 lbs. and 21,000 lbs. load | 1,450,800 |
| Maximum intensity of longitudinal shear (calculated by ordinary formula, weight of beam included) | 206.8 lbs. |

To take a set of readings, the screws were turned down till contact was made with the wires; then the readings were taken. In the log given above, which represent the test on piece No. 616 shown in the cuts, two sets of readings were taken on each micrometer. Columns 2 and 3 are readings on one side and columns 4 and 5 on the opposite side. Micrometer readings were discontinued above 21,000 lbs. load. With the high loads, the deflection will depend to a considerable extent on the length of time the load was left on the specimen before the readings were taken.

In the calculation of the results following the log no explanation of the formulas used will be given, as these may be found in every work on applied mechanics and in most of the engineers' handbooks.

If we neglect the weight of the beam itself, the bending moment, due to the load, will be uniform for a distance of 2 feet at the center, and gradually grow less till at the supports it is zero.

The bending moment due to the load on the beam is equal to

$$\frac{64,702}{2} \times 9 \times 12 \text{ inch pounds.}$$

The beam itself weighs 953 pounds. This weight is uniformly distributed and the bending moment due to this will be a maximum at the center of the beam equal to

$$\frac{953 \times 20 \times 12}{8}$$

The sum of the bending moments must have been equal to the apparent outside fiber stress f, times the moment of resistance of the section $\frac{I}{y}$ where I is the moment of inertia about the neutral axis and y is the distance from the center of gravity of the section to the outside edge.

$$\frac{64,702}{2} \times 9 \times 12 + \frac{953 \times 20 \times 12}{8} = \frac{f \times 15.875 \times \overline{15}^2}{6}$$

f called the modulus of rupture calculates as 5,917 lbs. The modulus of elasticity E is calculated by means of the formula for deflection. The formula for deflection for a certain increase in load is, for this manner of loading and for the spans taken

$$= \frac{283,834 \text{ load}}{E\,I}$$

By increasing the load from 1,000 to 21,000, the deflection was increased .8763".

$$.8763 = \frac{283,834 \times 20,000 \times 6}{E\ 15.875 \times 15 \times 15 \times 15}$$

$$E = 1,450,800$$

This expression for deflection may be derived from that given for a beam loaded at a point one side of the center.

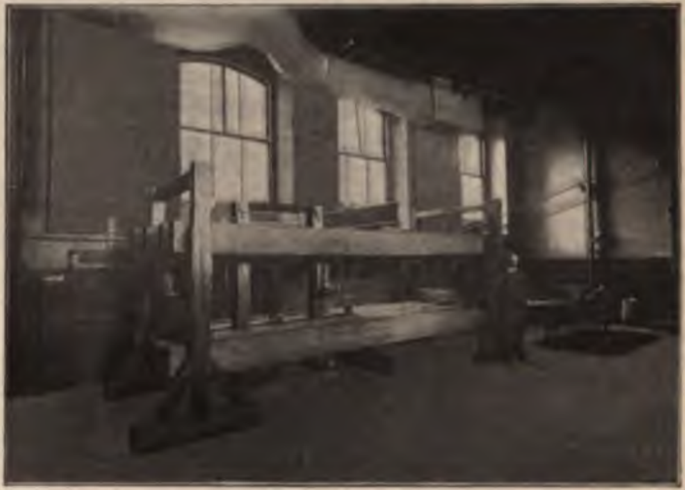


FIG. 8. MACHINE FOR TIME TEST OF BEAMS.

The deflection at any distance x when x is less than a is

$$v = \frac{W\,(l - a)}{6\,l\,E\,I}\,x^3 + \frac{W\,a}{6\,l\,E\,I}\,(3\,a\,l - 2\,l^2 - a^2)\,x$$

Put W equal to 10,000, l = 240, a = 132, x = 120, and the value v or the center deflection due to W will be found. Another load of 10,000, placed an equal distance the other side of the section, would produce an equal deflection, hence twice the above expression will give the value for the loading shown for the beam in Figs. 6 and 7.

The maximum intensity of longitudinal shear is calculated from the formula

$$\frac{3\ (\text{breaking load} + \text{weight of beam})}{4\ \text{breadth times depth}} = \frac{3 \times 65,655}{4 \times 15.875 \times 15} = 206\ 8 \text{ lbs.}$$

This is greatest at the support. When a beam bends, the upper half being in compression and the lower half in tension, there is a tendency for one part to slide by the other splitting through the center. This action takes place quite frequently in timber beams.

### Time Tests of Timber.

If a timber is kept loaded for a long time, the deflection resulting is nearly double that which would take place when the load was first applied. It is very common to find floors in mills which show the effect of this increased deflection with time. When the deflection, after years of loading, must not exceed a certain amount, the size of the timber has to be made considerably larger than would be figured by using the ordinary safe fiber stress.

A number of experiments in this line have been made at the Massachusetts Institute of Technology in past years. The results of these tests are given in Lanza's Applied Mechanics.

Fig. 8 shows a recent machine built to test large timbers. There are eight 6" x12" yellow pine beams of 15 ft. span in the machine at present. These have each been loaded with 6,330 lbs. center load since March.

The deflections were measured at first every day, later every week.

The moisture in the air and the decrease in cross-section, due to seasoning, are also recorded.

* * *

One of the remarkable operations in glass manufacture is the making of tubing for thermometers, especially for those used by physicians. The diameter of the bore is so small that it is scarcely discernible to the naked eye when not filled with mercury, probably being not over one-thousandth of an inch in diameter. The diameter of the hole must approximate a uniform size, but such is the remarkable viscosity of glass and the skill of the operator that at the Corning Glass Works this tubing is drawn regularly to a length of over eighty-five feet.

The method of drawing is quite interesting and is done by one man and a helper who have become expert at the business. By improvements in the process of manufacture the Corning Co. are said to have practically a monopoly of tube making. One of the prominent features of their process is the use of a tower into which the tubes are drawn and allowed to hang vertically until cool when they are lowered and cut into sections of convenient length.

* * *

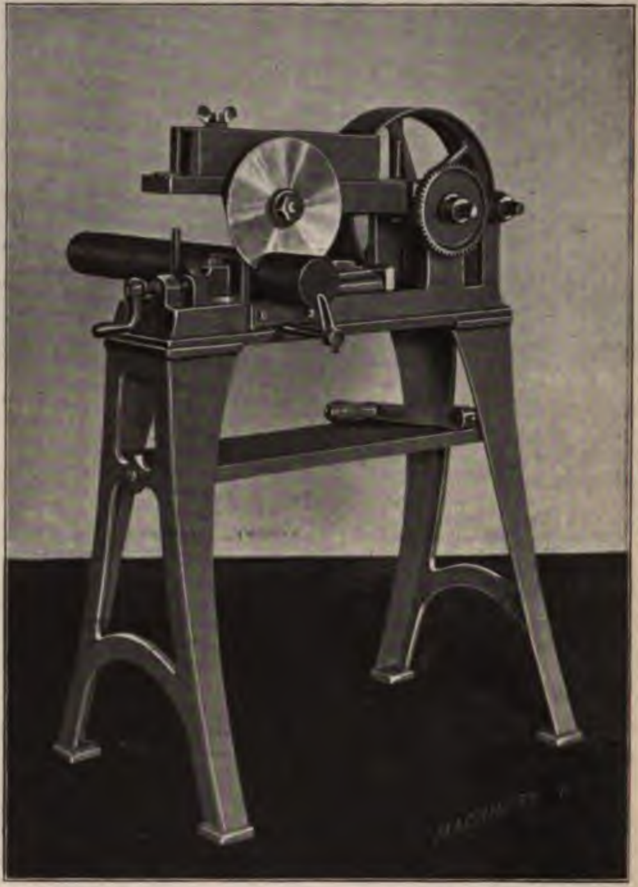
## CIRCULAR SAW FOR MACHINE SHOPS.

It is but comparatively few years since the shop saw came into existence, but it is used extensively, partly, probably, because of its low first cost and partly because, in spite of its defects, it has proved to be a very useful machine. We illustrate in this number a new circular metal saw designed to do the work of the power hack saw, but in a better manner. The circular saw has been entirely successful for sawing heavy structural shapes and this adaptation of the same principle to ordinary shop work presents some very interesting features. As will be seen, the saw is supported by an overhanging arm which swivels at one end and can be raised clear of the work if desired. Power is transmitted from the pulley shaft, through the two spur gears shown, to a pair of bevel gears, one of which is on the shaft with the larger spur gear and the other on a short shaft running at right angles to the saw arbor and connecting with the latter through another pair of bevel gears. The supporting arm for the saw swings about the center of the shaft carrying the larger spur gear. Two speeds, for sawing either hard and soft metals, can be obtained by transposing the two spur gears and the saw can be operated either by belt or hand power. The crank will fit either of the driving shafts, thus allowing a slow, powerful motion, or a rapid motion, as desired.

The feed is by means of a weight placed on top of the swinging arm and the feed is graduated by sliding the weight out or in. Among the special features of the machine are an adjustable post to regulate the depth of cut, and removable vise jaws, which enable special work, that cannot be held in the vise, to be done. This also makes it possible to saw at any angle.

It is claimed by the makers that the machine will saw straight with no loss of stock from the saw running sidewise; that the circular saws do not break in actual use and that they can be sharpened in a few minutes by unskilled labor, a small emery wheel and grinder being furnished for the purpose; that the saw will wear down only about an inch a year in an ordinary jobbing shop where reasonable care is taken in grinding, and that a saw will stay sharp long enough for a day of hard sawing and then will simply need to be touched up at the points.

A sample has been sent us of the end of a tube cut with this saw. The tube is 1¾ inches in diameter and a piece 1-16 inch thick was cut off, which shows a smooth, even cut. The pressure necessary to make a saw cut depends very much upon the number of teeth in contact. In sawing a railroad rail, for instance, more pressure will be required in sawing through the ball than in sawing through the web. It is not possible to entirely overcome this, but in sawing different diameters of round stock something is gained by having saws with coarser or finer teeth, using coarse teeth on large diameters and fine teeth on small diameters and tubes.



NEW METAL SAW.

If the saw be perfecty round, all the teeth in contact must cut, or none; therefore for the gravity feed there is an advantage in not having the saw perfectly round, for when the teeth are somewhat irregular, only the high ones cut when operating on large stock, while they all cut in small diameters. The saw acts more like a file than like a cutting tool and hence the shape of the tooth is not so important as its sharpness, which can be easily maintained if taken at the right time. Thin tubing requires a fine toothed saw, so that the distance between the teeth should always be less than the thickness of the tubing, as otherwise the teeth will catch. The machine is for sale by the Marshall and Huschart Machinery Co., Chicago, and appears to us to be a machine of considerable novelty and interest.

* * *

A Springfield, Mass., paper is credited with the following item: "The molders are grinding their axes and sharpening their sledge hammers to go to battle with the Springfield Foundry Co., which is using four scab wheelbarrows that were bought of the ——— company."

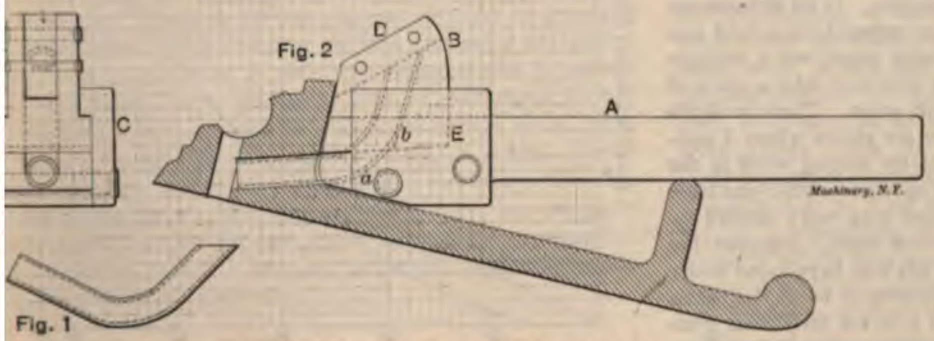
Lumbermen, blacksmiths and molders are all one in the eyes of this reporter. With a strike of this kind in progress somebody is likely to get hit.

# LETTERS UPON PRACTICAL SUBJECTS.

## A TOOL FOR SETTING AN OIL TUBE.

r MACHINERY.

s tool is one of the special tools that it was found neces- to build in manufacturing a new machine; a simple tool ne that fulfils all requirements. Its use is necessary when ng a curved oil tube, as shown by Fig. 1, into a piece of achine where there is but little room, and in such a way he curved part only will remain out. It was a little puz- at first to know how to hold the tube while driving it in ut changing its form or bruising the end. A tool was , however, for the purpose and found to be satisfactory. shown in Fig. 2. A is a handle, at the end of which is a



HOLDER FOR DRIVING OIL TUBES IN PLACE.

g block B. The sliding block is held in place by straps veted to the handle. You will notice a form cut in the e at (a) and also in the sliding block at (b), which is the form as the oil tube. Riveted in the sliding block is a D, which makes the stop for the end of the tube, and the der E forms the stop for the sliding block.

e operation is as follows: Place the bent end of the tube the sliding block, then slide the block and tube on the e until they come against the shoulder. This gives a solid ng so that the tube may be driven into place without harm. remove the tool after the tube is driven in, draw the handle This allows the block to slide out easily, as the ways are ly tapered. Then remove the block and the tube is in on.

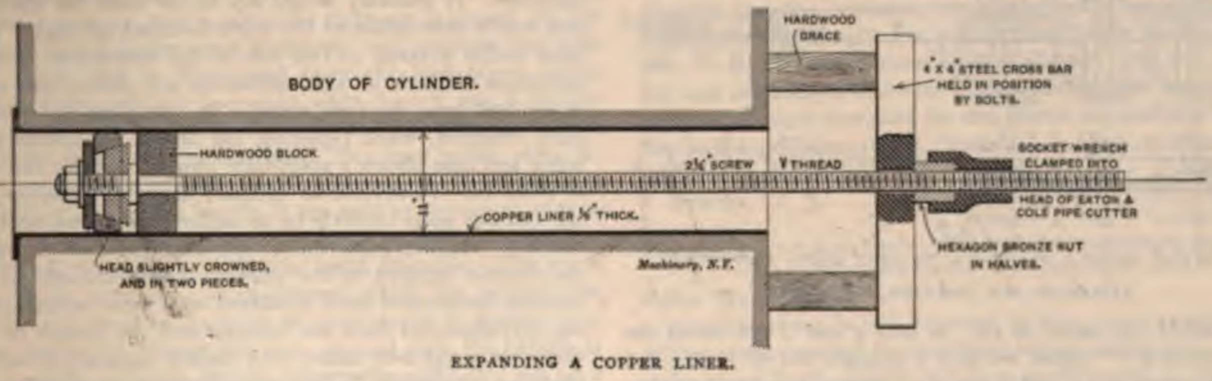
EDWIN C. THURSTON.

* * *

## 'HOD OF EXPANDING COPPER LINERS IN CYLINDERS.

r MACHINERY:

the manufacture of some large presses some time ago, there some cylinders eleven inches in diameter by about ten feet ches long, that were to be copper lined.


BODY OF CYLINDER.
HARDWOOD BRACE
4"X 4" STEEL CROSS BAR HELD IN POSITION BY BOLTS.
HARDWOOD BLOCK
2¼" SCREW
V THREAD
SOCKET WRENCH CLAMPED INTO
HEAD OF EATON & COLE PIPE CUTTER
COPPER LINER ⅛" THICK.
HEXAGON BRONZE NUT IN HALVES.
HEAD SLIGHTLY CROWNED, AND IN TWO PIECES.
Machinery, N.Y.

EXPANDING A COPPER LINER.

e following is a description of how this was accomplished: the cylinders had been bored out and faced off, they were l in a horizontal position and well supported. The copper which was seamless drawn, was placed with one end enter- e cylinder.

oss the other end of the liner, which was flanged, was l a stout block of wood, to which was attached a block and This was passed through both liner and cylinder, and se- at the front end of the cylinder. The liner was then pulled lace, being just large enough to go in under slight pressure, and of sufficient size to keep it from buckling due to the pressure applied, notwithstanding its length.

After the liner was in the cylinder it had to be expanded to make it fit the cylinder bore snugly and take out any indentations which may have been made.

The following was the method used: A cast-iron expanding head was made, consisting of an inner and outer piece fitted to each other on a taper, as per sketch.

The outside diameter of the head was turned slightly crowning so that the edge would not cut the copper, and also to allow for any non-alignment of screw.

This head was fitted to the end of a long bolt extending through the cylinder to the front end. The bolt was threaded almost its entire length, for a bronze nut which was made in two pieces so as to be easily removed, and which was held in a socket wrench at the front of the cylinder. Behind this nut was placed a four-inch steel cross bar, through which the screw passed, and which was braced against the face of the cylinder by two pieces, as shown, so that all strains were self-contained in screw-nut and cylinder. The socket wrench, before mentioned, was clamped into the head of an Eaton & Co. pipe cutter, and after the screw was centered, the machine was started, drawing the expanding head through the cylinder.

This operation was repeated as many times as was necessary, the head being expanded a little each time, by means of the nut and washer at the back of the head acting on the outer part of head, which outer part was in two pieces.

The head was well doped in grease so that it would move freely and not cut the copper.

A hardwood block of proper diameter was placed in front of the head to serve as a steadiment.

After the liner had been sufficiently expanded, the inside was well polished with emery cloth and oil, to ensure as nearly as possible a frictionless surface.

These cylinders were worked under a pressure of about thirty-eight hundred pounds per square inch.

A. DUNN.

* * *

## LEVELING WORK.

*Editor* MACHINERY:

This week the old topic of alignment of shafts came up with its high side advocates, who claim that the belt will run to the highest side of a pulley when the shafts are closer at one end than the other. I have met many good machinists who held this view and it was hard work to convince them to the contrary. Every machinist has heard so many times that a belt will climb to the highest side, that he takes it for granted to be true. The fact is, that it runs to the lowest side of the pulley when the shafts are not in line, that is, when they are not parallel with one another; or another way to state the case is, the belt will run to that side of a pulley where the shafts are nearest each other.

Another case came up where the shafts were out of alignment horizontally, that is, one shaft was level, the other was not by ¼" in four feet. The man who was sent to get the machine in line and started, reported as above, and was told it made no difference about that. While he said nothing, you could tell by the smile on his face, he did not believe it, but he was convinced when he started the machine. To have leveled up this machine would have cost considerably more, on account of attachments already made, and after leveling, it could not have run any better than it does now. However, the manager of the plant for whom the work was done was informed of the conditions as found and he put the question if it made any difference in the running of the belt on the pulley, and was told that it did not, when he replied he thought so.

This leveling business brings to mind a case where no level was to be had and an ordinary washtub was used instead by filling it nearly to the top with water, then blocking a straight edge up parallel with the water and working from this. It all depends on the circumstances as to what to use; for instance, in a field you might dig a shallow ditch and fill it with water, set a straight edge with the surface and go ahead; or you may take a piece of pipe and bend it at both ends and fill with water. These methods all accomplish the same end. But there are places where I seriously object to using a level, and that is for setting work in the shaper, lathe, ,drill press, planer or any machine where you have a platen or bed to measure from. I have seen work leveled by men who know better if only they would think. Suppose the machine is not level? (a good many are not that have come under my observation), and it is generally supposed to be so, for when this question is asked the answer is: If it is not level then I am not responsible. You can, of course, make the same allowance in your work that there is in the machine, but to my mind this is very unsatisfactory as compared with measuring from a bed or platen. A. Mertes.

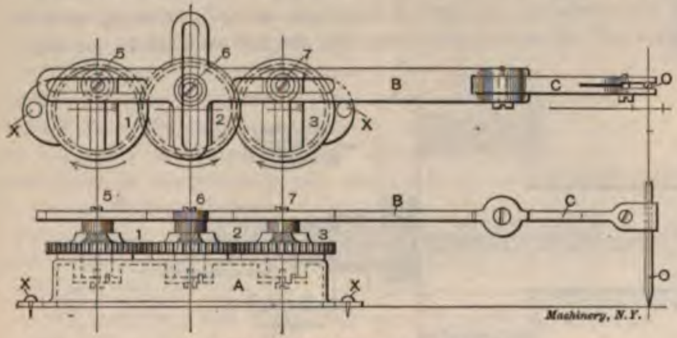
Emsworth, Pa.

* * *

## A DRAWING MACHINE.

*Editor* Machinery.

The machine tool here illustrated is designed to outline correctly an ellipse of any desired proportions between a straight line and a circle. Oval or egg-shaped figures having one end larger in diameter than the other and other curved figures can also be outlined by the use of this tool. In the figure, A is the base of the machine which is properly located on the drawing board and fastened by the thumb-tacks X X. On the base A and pivoted to it, are three equal-sized gears 1, 2, 3, each provided with a dovetail slot for locating and holding the moving pins 5, 6 and 7. B is the outlining bar provided with three slots, two in the same line and one at right angles to them. These slots fit the pins 5, 6 and 7, and the motion of the bar 3 is guided by the position of these pins on the gear. If the pins were set in the center, then bar B would not move at all. If pins 5 and 7 are set at the center and 6 at 1" radius, we have a straight line 2" long. If 6 is at the center and 5 and 7 are at 1" radius, then we have another straight line at right angles to the other. If we set 5 and 7 at ½" radius and 6 at 1" radius, we have an ellipse 2" long by 1" wide correctly outlined. If 5 and 7 are at 1" radius and 6 is at ½" then we have produced a duplicate of the preceding ellipse at right angles to it. If all the pins are set at 1" radius, then we get a circle 2" in diameter. We cannot enter into the possibilities of the great variety of forms of figures, reversed curves, etc., which, with the aid of this tool, can be traced, according to the manner in which the pins are set and the relations of the gears which may be changed so as to mesh differently. In constructing this machine tool, it should be made large enough to describe at least a 6" circle. One feature of the work produced on paper by this machine tool is the absence of all center points.



APPLIANCE FOR DRAWING ELLIPSES.

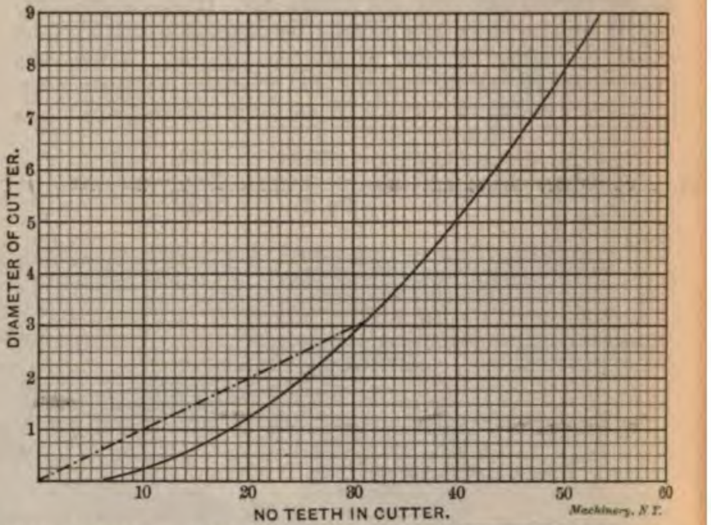
Boston, Mass. F. W. Clough.

* * *

## PITCH OF MILLING CUTTER TEETH.

*Editor* Machinery:

I send you herewith a diagram which shows at a glance the number of teeth that milling cutters of different diameter should have to conform to the formulas on page 958 of Kent's pocket book. These formulas are: Pitch $= .177\sqrt{\text{diameter}}$, and number of teeth $= \frac{3.1416\,d}{P}$. Milling cutters proportioned according to these formulas give good results in practice. In most cases for cutters under 3 inches in diameter use the dotted line, which gives 10 teeth per inch of diameter. Ray Carpenter.



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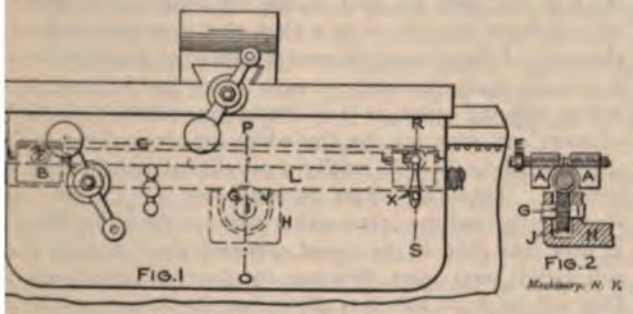
## A SUGGESTION IN LATHE DESIGN.

*Editor* Machinery:

My attention has been called to the suggestion by Mr. Olin Snow in the November issue of Machinery, that it would be an improvement to have engine lathes built with reversible lead screws. By having the screw reversible, the trouble incident to the local wear on this vital part of the lathe would, he believes, be overcome. He says that the greater part of the wear on the screw is limited to a portion next to the head-stock, and by making the screw reversible, the same effect practically would be realized as though the screw were replaced by a new one. The writer's experience has taught him that the condition mentioned by Mr. Snow is quite common on old engine lathes, and that it is a serious defect when long screws are to be cut on such machines. It probably would not be far from the truth to say that nearly nine-tenths of the work threaded on engine lathes is done within a range of two feet of the head-stock, and an examination of nearly all old lead screws will show a distinct jump in the lead near the limit stated. To overcome the defect, it is quite common, when repairing old lathes, to reverse the lead screw and thus obtain a practically unworn part for the split nut to work in. To reverse an ordinary screw is, however, quite a job and one quite unlikely to be undertaken unless urgently demanded. Having seen lead screws reversed and having noted the trouble incident to the change, I have thought of the reversible feature and have wondered why some of our enterprising manufacturers have not incorporated the feature in "one of their latest and best lathes with double back-action and patent medicine attachment." But after thinking considerably on the subject, I am convinced that, while the reversible lead screw may be a good arrangement if rightly used, it would, however, fail to be a benefit in the great majority of cases. In the first place the reversing of the screw would take quite a little time. A machinist would never think of reversing the screw unless he was given a job that positively demanded it, and having made the change, he would very likely not change it back again unless specific instructions were given him by the foreman to do so. If the screw were left in the reversed position, the screw would eventually become worn in the same way as before, and if a long

ɩ were to be cut, the results would be even worse than in
rs that had never been reversed, as there would be two in-
rate places in the generated screw instead of only one, as
arily occurs. Even under ideal conditions in which the
v is turned and worn as nearly equal as possible at both
a perceptible jump will surely occur at the junction of the
part with that which is practically unworn.

ving advanced my objections to the reversible scheme, I
now offer my improvement (?) for the consideration of MA-
ERY readers. Since the wear on the lead screw comes within
ited distance of the head-stock, and we accept that it is prac-
y limited to two feet or about the width of the apron of
nty-inch lathe, it is obvious that if a split nut be located on
eft side of the apron and used for all short work, the wear
e lead screw will be limited to that portion which is covered
e carriage. Then by having a second split nut on the right
of the apron in the ordinary position and using it only for
rate and long screws, it would be engaged with a portion
e lead screw that is practically unworn throughout its full
l instead of for a portion as with the reversible screw. The
nut on the left side of the apron would, of course, involve
ng the screw somewhat longer than is necessary now, but
is a minor matter. The two split nuts and other necessary
res would increase the cost somewhat over the present con-
tion, but it seems to me that the results attainable would
ɩ offset this disadvantage.



PROPOSED CHANGE IN LATHE APRON.

e method proposed for working the two nuts is shown in
1 and 2 in a general way, the minor details being omitted for
ness and simplicity. The split nuts open horizontally in-
of vertically, as in the usual construction, and are operated
ght and left screws. The screws should have a pitch of, at
¾", which would give an ample opening with one-half
of the handle D. The right and left screw K, to which the
le D is attached, also carries the pinion gear E, which trans-
motion through the rack C to the right and left screw F.
latter screw operates the left split nut B. The action of the
nuts is opposed, that is when the right nut is closed, the left
opened still farther from its normal open position that both
y when each is disengaged from the lead screw. Vice
, the right split nut is opened when the left one is closed,
being effected by having the right and left screws reversed
e jaws of the nuts so that when they turn in the same di-
n, an opposite effect is obtained. Now by having a stop
located so that the handle D can only be thrown to engage
ft nut when threading ordinary work, we have the condition
airs which has been outlined as being desirable. The screw
ly being worn for a short distance which lies between the
nuts, and when an accurate or long thread is desired, it is
sy matter to remove the stop pin and turn the handle D
e opposite direction, thereby closing the right split nut on a
ically unworn portion of the screw which continues for the
ravel of the carriage and not for a limited portion of it

It appears to the writer that this scheme is perfectly feasi-
nd is quite desirable, but to his knowledge it has not been
ed in general practice. If any readers know of a similar
e, a description would, I believe, be interesting to the read-
this journal.

fore I close this description of what Mr. Snow will probably
nate as a "freak" design, I wish to speak of another feature
d screws which is generally neglected, and that is the need
upport beneath them near the middle. Some makers apply an elaborate "kick up" arrangement that lowers when the carriage approaches and raises after it has passed. While this device accomplishes the purpose for which it is designed, it is scarcely an elegant or creditable arrangement for a machine tool. On shorter lathes, hooks are employed, which are supported from the shears to carry the weight of the screw, but it is obvious that the machinist cutting a long screw, has something more to think about than sliding these hooks along so that the screw does not sag. The result is that the screw is not supported at just the time it should be, since the deflection of a moderately long screw which is unsupported must certainly have an appreciable effect on the accuracy of the thread being generated. The weight of the screw being carried by the nut, the wear on this part and on the screw is unnecessarily increased. To obviate these troubles, I will offer, with the other "freak" scheme, the idea of supporting the lead screw by a number of wheels, like G, which may have shallow teeth cut, thus making them worm wheels that will revolve slowly by the motion of the lead screw. The construction of the split nuts enables this form of support to be used without difficulty. The supporting arrangement keeps the screw in perfect alignment, and also feeds a constant supply of lubricant to the screw from the cavity J, which is to be filled with a thin oil. The lubrication of lead screws is something that is often neglected, and one of these supports would be a good thing on the shortest lathes built, as it would fulfill the lubricating feature admirably even if it were not needed to support the screw.

Fig. 2 shows a section of the supporting device through the line P O, and a section of the split nut A through line R S, the two sections being combined for convenience.

I notice that Mr. T. B. C., in a letter published in the December issue, pitches into my proposed shaper-slide adjustment and lets daylight into it without any compunction whatever. He has my thanks for availing himself of the privilege which the editor of MACHINERY seems to extend to all—that is, the right of expressing individual opinions. But, while in theory I can agree with Mr. T. B. C. that: "Any design that tends to place the adjustments of machine parts out of the instant reach of the operator is radically wrong, and also that an operator who is not capable of looking after the proper adjustment of the machinery in his charge is incompetent, etc.," practice has taught many a tool-builder that the less chance allowed for adjustment, within reasonable limits, the better. The writer not long ago saw a new gear-cutter in process of construction which was specially arranged so that the operator could make no mistake in the setting and could not by mistake tighten the slide so as to interfere with its proper action. A movable head which was provided with adjustable gibs was, however, arranged so that a large screw-driver would be necessary to effect any change in the adjustment. In short, the whole machine was so constructed that the operator could not "tinker" with it, as bitter experience had taught the builder the danger of the practice. Mr. T. B. C. must remember that all men who run machines are not machinists, and that the proportion that are is steadily decreasing every year, and for this reason the machine that offers the least temptation to the "tinkerer" is likely to give the best satisfaction in the end. F. EMERSON.

Newark, N. J.

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## CRANES HIGH AND CRANES LOW.

*Editor* MACHINERY.

The title above is not intended to hint at an analysis of the ceiling-room required for installing cranes in general, but merely seeks to set forth certain variations in the price of these useful machines which seem almost abnormal.

Not many years ago the writer had occasion to buy two 4-ton traveling cranes, with hand-chains for performing the respective functions of hoisting, traversing the trolley and traversing the bridge, the span of the latter being about 16 feet—with a load rise of 12 feet. He drew up a somewhat meager specification which, however, covered the important points of ample strength, reasonable durability, convenience in handling, ease of working, due to roller bearings in both trolley and bridge wheels and, of course, the capacity to handle 4-ton loads.

These specifications were sent to nine of the best-known makers of such articles, with results as regards prices shown in the table below, the bidders being marked respectively A, B, C, D, etc. The last column quotes remarks appended at the time of receiving and tabulating the bids, but will hardly be supposed to furnish information in the language of the bidder. There were a number of other columns in the original table, giving a variety of data which it is hardly worth while to mention herein.

| Bidder. | Net Price. | Days for Delivery. | Remarks. |
|---|---|---|---|
| A | $1220 | 42 | Good—but they want the earth and the fullness thereof—too much weight —and wait. |
| B | $654 | 30 | No roller bearings—too dear—has worm-gears to waste power. |
| C | $556 | 21 | Too dear—too heavy—too worm-geary. |
| D | $554 | 21 | Good — spur-gears —2 speeds—quick lowering—chilled wheels. |
| E | $528 | 15 | Good — spur-gears —2 speeds—somewhat rough finish. |
| F | $520 | 30 | Good—best and handsomest design—spur cut-gears—chilled wheels, etc. |
| G | $491 | 21 | Too dear—too light—worm-gears. |
| H | $436 | 21 | Fairly good — spur-gears—2 speeds—somewhat rough. |
| I | $376 | 21 | Good, but a little rough —spur-gears—2 speeds—low price. |

The somewhat startling results in the matter of prices are shown as ranging from $376 to $1220 for the aggregate of the two cranes complete, delivered at destination without allowing for the permanent tracks on which the bridge-wheels were to run. In considering the tremendous differences in these figures, which seem to vary more than a set of bids for similar machinery usually does it is only fair to say that some of the cranes bid upon were a good deal heavier than others, and that some were finished in a much more elaborate manner, the higher priced ones being built more in the style of machine-tools, while lower prices, in some cases, represented considerable blacksmith work. The weights ran from 1800 lbs. to 5700 lbs., but the price of the latter was less than half the price of one of the lighter ones. The 1800-lb. machine was 40% dearer than one of the heavier ones. The price per lb. ran from about 7 cents to 17 cents. The latter price, however, did not represent a very nicely built crane.

The matter of extra weight should not in the case of a crane be always regarded as a positive advantage, as it would be in a machine-tool. On the contrary, lightness, consistent with ample guaranteed strength and durability, would in a traveling machine of this kind be an advantage, by reason of the less power required for its operation—just as it would be in a bicycle, a trotting sulky or a railroad car. The features of fine finish and carefully-fitted joints would, of course, be desirable points in the make-up of a crane, provided they did not cost too much; but few users would be willing to pay 300% or 400% advance for these attributes alone. The matter of beauty of appearance would, of course, be worth something, but the writer could not find that any of the machines, with perhaps one or two exceptions, had any particular claims to æsthetic excellence.

Just why such a varied condition of crane prices exists, or did exist at that time, it is difficult to find out. It would seem as if some of the people wanted to make a great deal of profit or else intended to embody abnormally elaborate ideas in design and construction. The low bidders, on the other hand, must have been wiling to make their profit extremely small, approaching perhaps a minus quantity, and must have had a faculty for throwing things together rather roughly, but so that they would yet answer an excellent purpose. This has for several years past been manifested by certain two cranes which were purchased at the lowest price given in the table—and which have been at hard daily work.

This does not seem to be a case where cheapness of manufacture was obtained by making work in large batches on the duplicate system, or by the use of jigs and other special tools, or both, as in the traveling-crane business nearly every individual machine seems to be built to order to suit the special conditions under which it is to run.

Whether a perusal of this article may set the crane makers to studying as to whether they had not better start a "crane trust" for the unification of prices, is an unknown conundrum. Let us all devoutly hope that if they do they will not seek to market their products at prices anything like those given at the top of the table.

OBERLIN SMITH.

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## SMALL THINGS IN MACHINE DESIGN.

*Editor* MACHINERY:

In designing any piece of machinery some attention should be given to those small details which add to its durability and strength, and also to the safety and convenience of the men in charge. The following notes regarding some of these details may be of some value to young draftsmen.

When cleaning around an engine, if you get your hand ornamented with a few scratches and gashes from some nice (?) sharp corner, you will undoubtedly praise the chap that designed the engine in words that, in print, are best represented by dashes.

Now it is usually just as easy and cheap to have round edges as sharp edges and bayonet-like corners, and it is the same with hexagon nuts, have the chamfered side up and if there is any fear of scratching finished surfaces the angles of the nut can be slightly eased off on the faced side as is done with case hardened nuts. Square headed nuts are very frequently placed with the chamfered side next to the work so as to put less strain on the bolt, but they are used mainly for rough work where they are either out of sight or in a place that does not need frequent cleaning. Fillets should be used wherever an angle is formed, as it not only makes the part stronger than a sharp corner, but also makes cleaning easier, as it is almost impossible to take a bunch of waste and wipe out the dirt which gets in a sharp angle. A simple experiment will readily show that a round corner is the stronger. Take two pieces of paper and cut the one with a sharp corner and the other with a curve as shown in Figs. 1 and 2; now take hold of the round cornered piece at each end and pull until it tears apart, then tear the sharp cornered piece apart. This will be done with less effort than the former, proving that the round corner is stronger than the sharp corner.

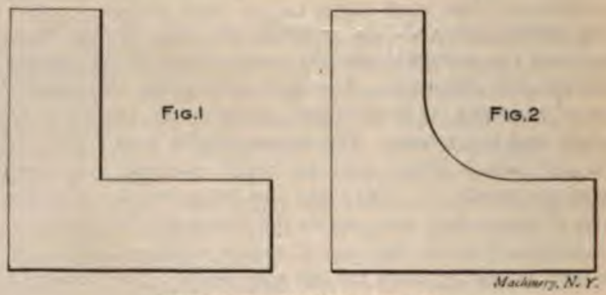
Fig. 1 Fig. 2

FILLETS VS. SQUARE CORNERS

When one piece of a machine moves to and fro on another piece it will in time cause wear and a shoulder will be formed; therefore, have the piece, on which the other slides, notched or grooved transversely, so that the sliding piece will pass over it slightly. This will prevent the formation of a shoulder, also a smash up when wear is taken up. A well-known example is the piston and cylinder of a steam engine, in which all danger of forming a shoulder is avoided by having a counter-bore at each end of the cylinder. Another example is the crosshead and guide. In these well known examples the provision for wear is seldom, if ever, overlooked, but in conical pieces it sometimes is. Frequently conical friction clutches need to be turned down to prevent slipping, but if the ends were notched no shoulder would have been formed, and consequently they would always work satisfactorily.

Pieces that are subject to wear should have enough metal added so that, when they need to be trued, it can be done without making the part so weak as to be liable to fracture. A piece of a machine may be sufficiently strong for the work it has to do, yet a slight blow or fall may cause it to break; therefore, all parts should be made strong enough so that they can be handled without fear of breaking. Mr. Meyer, in his excellent book, "Easy Lessons in Mechanical and Machine Design," gives an interesting example of a steam engine cylinder, 4 inches diameter by 6 inches stroke, the walls of which, if made strong enough to resist a steam pressure of 121 pounds per square inch, would need be only 3-32" thick.

Every machine is liable to have some part broken and the most expensive parts should be protected against injury by having some of the cheaper parts made weaker so that in the event of any accident they will break first and in most cases prevent further damage. For this reason it is a good plan to make the flange on a cylinder cover thinner than the flange on the cylinder, as a cylinder cover is a good deal cheaper to make than a new cylinder.

On machines that are so high as to need steps to facilitate getting at parts to be oiled, there should be hand rails so that there will be no danger of the attendants falling off. Likewise all platforms, no matter how wide, should have a railing, as one is liable to slip on the iron gratings of which the platforms are usually made.

Obviously, a pipe used for steam should never be used for a hand rail, but some years ago some economical crank conceived the idea of using the hand rail on the locomotive for conducting steam to the blower with the result that a number of firemen received burns and some had falls from the running-board before the practise was abolished.

Never use any contrivance which is liable to injure the persons working around it. To put a man's life in jeopardy for the sake of saving a few dollars, is, to say the least, inhuman. When a ladder is placed alongside a wall it should in no case be less than 2½ inches from the wall and when possible about 9 inches, as then there will be no danger of any one falling off for lack of room to get a good foothold. The ladder should extend about 2 feet above the top of the wall, chimney cap or whatever it may be, so as to have something to hold on when getting on or off the top, or, as in the case of freight cars, a handhold may be placed on top; about 12 inches from the edge is a convenient distance. In some places the ladders are placed close to the wall while there is plenty of room to have them further out. A ladder should always be inclined if room permits. There is one ladder that I remember very well, which was attached so near to the wall that it was necessary to place my feet lengthwise on the rungs, and, one day, when I had on a pair of new shoes, my foot slipped—and the force of gravity did the rest.

Have every part of a machine so that it can be easily examined and taken apart for repairs and without the use of special tools, if possible.

Proper facilities for oiling all moving parts should be allowed and where possible all such moving parts should be enclosed to prevent accidents. The coverings should be made so as to be easily removed when necessary and have suitable openings with hinged covers so that journals, etc., may be readily inspected.

New York. **Charles G. Peker.**

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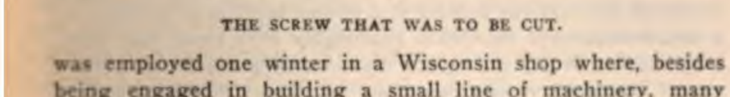
## CUTTING A LEAD SCREW.

*Editor* Machinery:



THE SCREW THAT WAS TO BE CUT.

As it is long since I have seen an article on lead screws in Machinery I take the liberty to revive the subject. A great many upon reading this article will say that it is not much of a job to cut screws. I admit that it is not, but to cut a screw 12 feet long on a lathe 10 feet long is quite a difficult job. I was employed one winter in a Wisconsin shop where, besides being engaged in building a small line of machinery, many other jobs were done. A short time after I commenced work in the shop, there came a dull spell and the proprietor decided to set his men at work on six 16-inch engine lathes he had begun to build, some years previous, but which had never been finished. When it came to cutting the lead screws, the old hands were naturally given the preference, but they all said they could not do the job, as the largest lathe was not big enough. Then the proprietor, a man of few words, came to me and said: "Can you cut those screws?" I answered: "Yes." "I have no lathe in the shop" said he, "long enough to take the screws in, and for this reason the rest of the men refuse to cut them." I told him I thought they could be cut in spite of this difficulty, and he answered, "Go ahead." Now the longest lathe in the shop was 10 feet in length, of ancient design, and had been used very hard. Nevertheless I prepared for business. The screw being made of stock already turned the right size, I had only to cut the threads and "neck in" the bearings. The screws were in bars of various lengths, but some inches too long, and they were cut, as are all lead screws, the entire length with the exception of the portion at the head of the lathe. This was left uncut for the proper distance, while at the other end it was "necked in" for the bearing and threaded for a nut. The end at the head was also "necked in" for the bearing, turned for the driving gear and threaded for a nut. My first operation was to take out the spindle in the footstock, after which I bored a hole in a bronze bushing the size of the screw to be cut. Then I turned the bushing to fit the footstock in the place of the spindle, and as a follow rest was to be used, I made a bushing of the same size for that. I then drilled and tapped for a screw through the footstock and also for one through the bushing for the follow rest. Having a chuck placed on the spindle of the lathe, I put the end of the screw in same, letting it enter the width of the jaws which were one inch. I then adjusted the chuck till the screw ran perfectly true and secured the bushing to the follow rest on a line with the center of the work. Then I started cutting the screws, running the chip the whole length instead of cutting part way and using a steady rest. The screw, however, began to chatter so that nothing could be done with it. So I began an investigation to find the cause of the trouble, and loosened the bolts that held the bushing on the follow rest; but I could only get it off by unscrewing it with a pair of pipe tongs, and when I came to the uncut part I had to wring it around and wear it off. When it came off, I found that the sharp edge on the screw being cut had worn a thread in the bushing one-sixteenth inch deep. A machine steel bushing, case-hardened, lasted longer than the bronze one, but the screw cut just the same after it had worn through the case-hardening. Then the idea came to me to make one of cast iron. The bronze and steel bushings were worn out in cutting two screws and part of a third, the cast iron one cut the remainder of the six, and when these were cut I removed the bushing and found it in good condition. The next operation was to "neck" the screws for the bearing and the thread for the nut, which was accomplished by placing each end in the chuck, allowing enough to cut off the part in the chuck. Then the screw was turned and the other end was cut off. The screws when completed were accepted by the proprietor as being all right and were called by him a very neat job. **A. F. Notroh.**

Providence, R. I.

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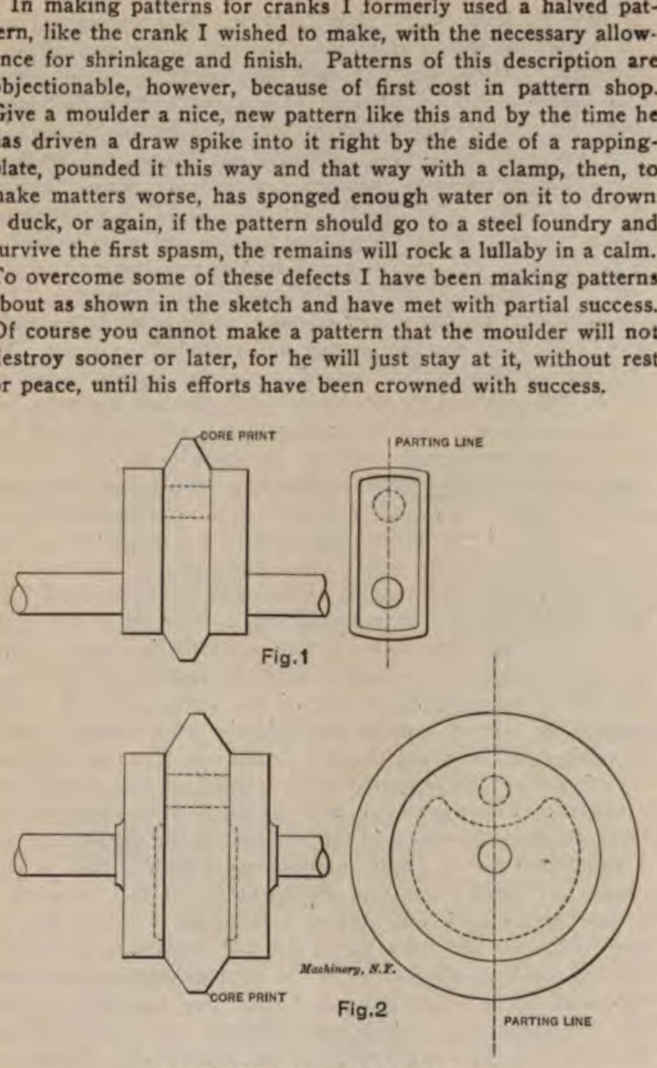
## PATTERNS FOR CAST IRON CRANKS.

*Editor* Machinery.

Having had occasion, at different times, to use return, or bell cranks for different purposes, I tried forgings, cast iron and steel castings. Of course cranks for extreme duty should be forged of steel. Cranks of steel castings are amply good for a great many uses but are too expensive, forged cranks being cheaper and more reliable. Cast iron cranks, when properly made, and of the right proportions, will give excellent satisfaction for a great variety of uses. I have successfully used them in places where it was supposed that nothing but forged cranks would answer.

We are all well acquainted with cast iron engine shafts in engines made twenty-five or thirty years ago. In my recollection I can recall no case of a cast iron engine shaft breaking, but I do know of a number of breakages of solid forged cranks. I believe I am safe in asserting that I have seen at least fifty broken forged cranks and some of them quite large. Recently, I saw a five-inch electric light engine shaft broken and about the same time, one near the same dimensions, in an ice machine. The cranks used in oil-well engines break very frequently. Now I don't want to be understood as recommending cast cranks for all purposes, but I do know that they are entirely satisfactory for a number of uses and, by somewhat increasing their size, they will successfully replace forged cranks for many uses, and at much less cost.

In making patterns for cranks I formerly used a halved pattern, like the crank I wished to make, with the necessary allowance for shrinkage and finish. Patterns of this description are objectionable, however, because of first cost in pattern shop. Give a moulder a nice, new pattern like this and by the time he has driven a draw spike into it right by the side of a rapping-plate, pounded it this way and that way with a clamp, then, to make matters worse, has sponged enough water on it to drown a duck, or again, if the pattern should go to a steel foundry and survive the first spasm, the remains will rock a lullaby in a calm. To overcome some of these defects I have been making patterns about as shown in the sketch and have met with partial success. Of course you cannot make a pattern that the moulder will not destroy sooner or later, for he will just stay at it, without rest or peace, until his efforts have been crowned with success.



ARRANGEMENT OF CORES FOR CRANKS.

Fig. 1 shows a common crank, using a core to make the throat. Fig. 2 is on the same principle, being used to make double disc cranks. This method permits the pattern to be made in a more durable form, and in Fig. 2 to be cored out for a facing strip as shown by the dotted lines. In both cases there is need for only a half core box. **Hugh Hill.**

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## POINTS IN WHEEL TEETH DESIGN.

*Editor* Machinery.

In reference to Mr. Webber's remarks on wheel teeth, November, 1899, I note that he points to the method of calculation of strengths on the basis of the whole of the pressure coming upon one corner of a tooth. Undoubtedly the whole pressure does come upon one corner of one tooth in the case of large cast gears and in fact in all gears if the bearings of the shaft become even very slightly out of line. The adherence to old methods is very strongly marked in the design of gear teeth. In a spur wheel the teeth stand up straight-edged from the wheel rim as though specially so formed in order to present the salient corner for the purpose of having the same broken off in due accordance with the formula for strength above referred to.

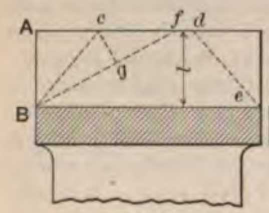

FIG 1.

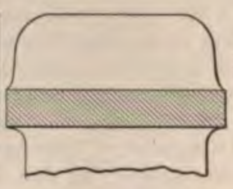

FIG. 2.

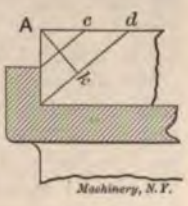

FIG. 3.

It would be more fitting to call it a formula for weakness. In Fig. 1 the line B C, along which the tooth would break if struck hard enough at A, would be inclined at an angle of 45 degrees if the tooth were parallel-sided; and B C would be the line of least strength of a homogeneous material. At least, so it seems to me. I have proposed to cut this corner B A C off the tooth from the beginning and to shape the tooth thus: B C D E. The tooth corner is now at C and if this point receives a severe blow, the tooth would break along the line Bf, the angle C Bf being equal to Cf B and C B being equal to Cf just as A C was equal to A B. By this design I have increased the strength of tooth in the ratio Bf to B C. It is now clear that assuming a corner blow at A and a fracture along Bf, no tooth can be stronger than the strength along Bf. The tooth, therefore, must be wide enough so that point f will fall to the left of corner d, and it need be no wider than this. The width to meet these requirements may be obtained by multiplying Bf by a certain factor.

To find the factor, we proceed as follows: From C drop a perpendicular on Bf; call this Cg; call the length of the tooth l; then the factor required is l ÷ Cg. Roughly, the width of Fig. 1 is double of Cg. Hence the maximum breadth of tooth Be will be twice Bf. This assumes, as above, rectangular teeth, and the conclusion requires modification because the tooth really thickens out to the root, and in proportion as the breaking strength is increased thereby, so may the breadth be diminished. Probably some such form as that in Fig. 2 would practically comply with the conditions of avoiding corner pressure, though personally I prefer the form B C d e as having more of character in it and showing in its form the reasoning that leads up to it.

On the assumption of rectangular teeth, it is seen that twice Bf is about four times l and so the teeth would have a breadth four times their length. This is a usual proportion with square-cornered teeth and these almost invariably break along B c showing that they are unnecessarily wide for their line of minimum strength. I have nothing new to add on the score of length, having found no reason for going back on the proportion I adopted several years ago, of making the length equal to half the pitch. It is now over twenty-two years since I first tried to have this done, but it was not until sixteen years after, that I found the opportunity of carrying it out, and then only in smaller gears, the use of large gears having so greatly diminished since the introduction of rope driving and later of electrical work.

In shrouding a wheel it is customary to consider that the tooth is strengthened, but this is doubtful. In Fig. 3, for example, the unshrouded tooth breaks along the line to d with a leverage Ak. Shroud it, however, up to the middle and it breaks along a line to c with a lever arm at half Ak. While the lever arm is halved so is the length along the line of break, and, so far as corner breakage is concerned, the tooth is no stronger for shrouding. But if this breaking corner is left off to begin with, the shrouding may be used to stiffen the tooth against breakage and pressure along the full line of the tooth face and this may be made use of to stiffen a narrow tooth such as lack of space sometimes renders it desirable to adopt. **W. H. Booth.**

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## TO PREVENT RUST ON SOLDERED ARTICLES.

*Editor* Machinery:

In your December issue, I note among "Odds and Ends for the Shop," some advice for the prevention of rust when soldering steel. This is all right as far as it goes, but in my opinion it does not go far enough. I somewhere obtained the idea of a process, which I now present to your readers and which I have found to fully neutralize the acid, something I was unable to satisfactorily accomplish with the process described in Machinery.

After soldering in the usual manner and wiping off all superfluous solder, boil the articles in a strong solution of sal-soda for a few minutes and then wash thoroughly with clean, hot water, and as soon as dry oil lightly while treating the lot to prevent rust. This may require an hour or more. Now expose the articles to a dry heat, in an oven, for instance, for ten or fifteen minutes, the heat being enough to give a good straw color to the bright steel parts. This heat is, of course, sufficient to remelt the solder, thus necessitating fastening the parts together other than by the solder alone. My work was of such a nature as to provide this. The final heating and a further light oiling, I have found perfectly successful, and no signs of rust showed on the inaccessible parts, even after several years. **C. S. Beach.**

Bennington, Vt.

## ABOUT INSERTED TOOL HOLDERS.

*Editor* MACHINERY:

Referring to the article by "Bell Crank" in the January number of MACHINERY, on the subject of inserted cutter lathe tools, possibly my own experience will give a little explanation for the reason these tools are found in so few shops. When these tools were first put on the market, or came to my knowledge, quite a number of years ago, they appeared to me as a great improvement over the forged tools, particularly as far as economy is concerned. I bought a half dozen of them and distributed them among what I considered my most progressive men, with instructions to call on me if they wanted more of them. Several months after, my attention was called to them, and I looked the matter up to find who had them in use, with the result that it was quite a hunt to find the original tools, and no one was using them. On questioning the workmen, I found they gave me no sufficiently good reason for dropping their use, and that they had hardly given them a fair trial. After another lapse of time, I visited a shop where they were in common use and satisfied myself that there was great economy in these tools, particularly in a shop like my own, where the men had at that time free access to the blacksmith, the result being that at most any time, I could find from two to four men waiting for the blacksmith to make or re-forge a tool. I also found that an inexperienced man would grind a tool but once or twice, before it must be redressed. I immediately purchased enough inserted cutter tools to supply every lathe and planer in the shop, and having learned wisdom by past experience, I put away in the tool room all the forged tools that these would replace, with instructions that for one month, as a trial, no forged diamond points or round nose should be given out. The result was that, after the first few days, there was no call for the forged tools and never has been since, and the same men who apparently condemned these tools on first trial would call for them now. Of course, they will not take the place of all forged tools, as some forms of tools must of necessity be forged, and in fact are better. This, perhaps, will account in a measure for the failure of many shops to use the cutter tools. The men do not have a chance to get thoroughly used to them.

F. H. N.

* * *

"In spite of all the good speeches which are made, it must be confessed that the average of oratory at technical meetings is low. There is, in general, no lack of speakers, and neither is there lack of knowledge; but it often happens that the men who speak do not know, and the men who know do not speak. In addition, we have the man both knows and speaks, but cannot express himself to any purpose." London "Engineering."

This may be true of those who speak at technical meetings, but the case is somewhat different for those who write for technical papers. The man who writes but does not know receives his manuscript back; the man who knows is generally not afraid to write, and the man who both knows and writes, but yet does not know how to write, has his manuscript corrected gratis by the editor. The moral is that all who know should write, even if not good writers.

* * *

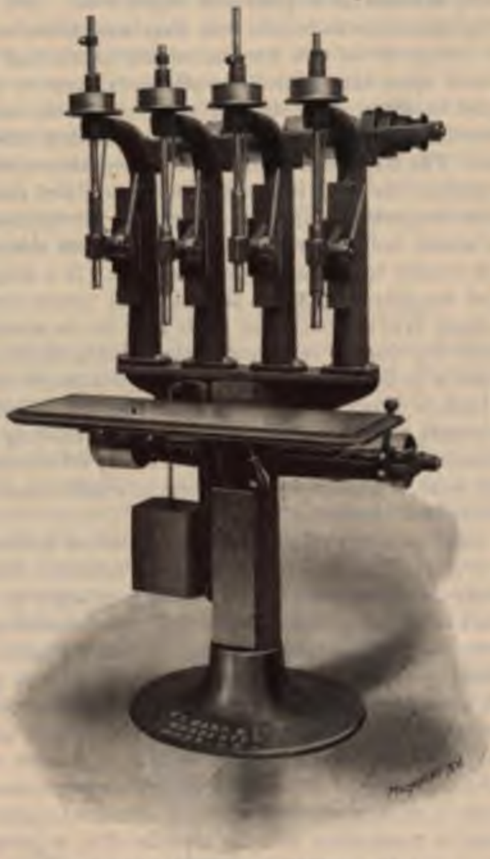
## NEW SENSITIVE DRILL.

A newly-designed sensitive drill, having four spindles, is illustrated herewith. It is built by H. G. Barr & Co., Worcester, Mass., and has several new features for this type of machine.

The drill belongs to that class which has separate driving cones for each spindle, giving the usual range of speeds to each spindle independently. It is designed with a gap or throat where the table is generally used and for a vertical distance of 8 inches has a swing of 16 inches. Below the top of the table slide there is a swing of 14½ inches. The driving cones run in a bracket cast in one piece and bolted to each post, thus increasing the rigidity of the posts. The cones are turned inside and out and run on a stationary shaft having an oil groove its entire length. The oiling is done through holes in the brackets between the pulleys, which makes a quick and positive means for keeping the pulleys lubricated. The counter cones are mounted in a bracket on the back of the columns on a shaft turning in babbitt bearings. These cones are also turned on the inside and the shaft is driven by tight and loose pulleys.

The table is large and is counterbalanced, which adds greatly to the convenience of the drill. It has a vertical traverse of 22 inches, giving a maximum distance of 33 inches between the spindle and the table. An oil groove 1¾ inches wide runs entirely around the table.

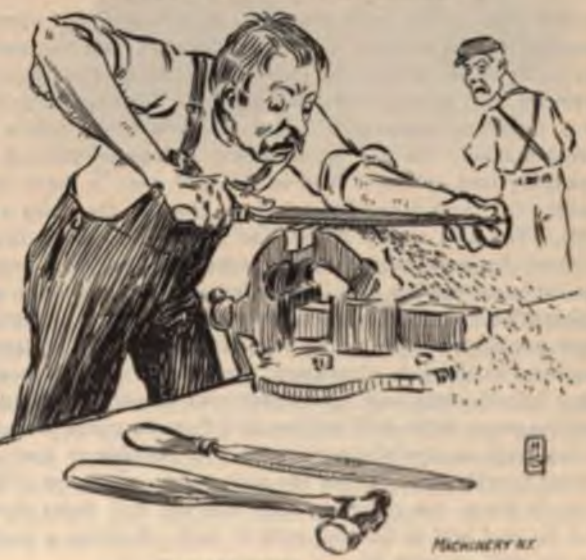
The spindles are made from forged spindle steel having a diameter of ⅞ inch in the quill and provided with a No. 1 Morse taper hole. Fibre collars are provided at both ends of the quills and collars splined to the spindles between the upper fibre collar and the take up nut prevent the latter from changing when properly adjusted. The quills are provided with steel feed racks dowelled on and they are graduated, showing the depth of hole being drilled. The vertical traverse of the quill is 3½ inches and the vertical adjustment of the head 8 inches. The heads are counterweighted and are clamped in position by handles instead of by the use of a wrench. Unlike the engraving, the feed levers pass clear through the collars, giving one end always in a convenient position. The belt-shifting device is quite novel and the drill is made with either two, three or four spindles, as desired.



MULTIPLE SPINDLE SENSITIVE DRILL.

* * *

## SHOP TERMS ILLUSTRATED.


MACHINERY N.Y.

WORKING FIT.

# MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—7.

### BORING IN THE LATHE.

W. H. Van Dervoort

A large portion of the work done in the lathe may be classed as boring work as it comes under the following classifications: center rest, carriage, face plate and chuck work. An example of a boring operation under the first class was shown in Fig. 54, article 6. As work of this kind is usually performed on solid stock, a hole must first be drilled sufficiently large to allow the boring tool to enter. The drilling of this hole can be done to good advantage in the lathe by using a twist drill held on the tail center. The taper shank drill with holder, shown in Fig. 58, is best suited to this work as it clears itself readily of the cuttings and the holder prevents injury to the shank. In no case should the taper shank drill be held by a dog secured on the shank, as it is quite certain to slip and injure the tool. If a dog is to be used at all for this purpose, it should be in connection with a straight shank drill provided with a flat spot on the shank for the set-screw of the dog to seat upon. When considerable drilling of this kind is to be done in a lathe, it is advisable to have a set of drill sockets fitted to the socket in the tail spindle. This not only makes a more satisfactory method for holding the drill, but overcomes the danger of the drill drawing off the tail center and being bent or broken by the cramp it would receive due to the single-handed holder.

When holes of a considerable depth are to be drilled in this manner in steel, it is difficult to properly lubricate the cutting edges of the drill, and often the work and tool begin to heat and the cuttings to fill up the flutes. The drill must, therefore, be frequently removed for oil and cleaning. These difficulties are almost wholly overcome by using the oil tube drill in places or this kind, as it provides for a constant and liberal supply of oil at the point, and this not only improves the cutting and clearing of the chips, but carries away the heat of friction and thus enables the crowding of the drill to its full cutting capacity. As in this class of drilling the drill does not rotate, a common socket can be used in connection with the oil tube drill, it being simply necessary to tap for a small gas pipe connection with the side of the socket over the supply hole in the shank of the drill. In an operation of this kind the important point is to get the drill started true. If the work has been centered for other operations previous to the drilling, this center forms a seat for steadying the point of the drill in starting. Even though this center runs perfectly true, it cannot be relied upon for starting the drill true. It is, therefore, necessary to steady the end of the drill in a different manner. In Fig. 59 is shown a common method. The steadying tool, which is held in the tool post, is made to bear against the front side of the drill, as close to the point as possible. The drill should be held so that one lip is on the back side of the work surface or opposite the steadying tool. As the cut is started, the drill is crowded slightly back of the center, making the one lip do all the cutting. This makes it virtually a rigid boring tool that cannot sway and produces a surface concentric with the axis of rotation. Just before the drill begins to cut a full diameter hole, the steady tool should be backed away and the point of the drill left free to follow the center of rotation. If this work is carefully performed, it is possible to start a drill almost exactly true. When the surface into which the drill is to enter is plane, the centering tool with flat drill point shown in Fig. 60, and held in the tool post, is used. It forms a good seat for the drill to start in.

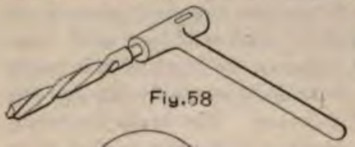


Fig. 58

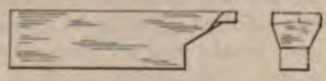


Fig. 60

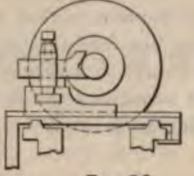


Fig. 59

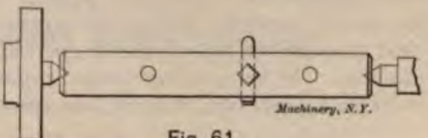

Machinery, N.Y.

Fig. 61

For uniformly true and central holes the drill cannot be relied upon, and its use in the lathe is confined almost entirely to the opening up of the work previous to using a boring tool. For example, if a 1" hole is required in a piece of work held on a face plate or in a chuck, a 1" drill could not be depended upon for anything like a satisfactory result and a 63-64" drill followed by a 1" reamer would be almost as bad. The only correct way in such a case would be to first use, say, a 15-16" drill which would remove most of the stock and allow a boring tool to enter. It can then be bored with the boring tool to within the proper diameter or, if it is to be finished with a reamer, it should be bored to within about 1-100 of an inch of the exact size, which trues the hole perfectly previous to the reaming. The reamer should be held on the tail center which latter must be exactly central. If the tail center is offset, a tapered hole will necessarily result.

The size of drill to use for opening up previous to boring depends upon the nature of the work. If the finished hole is to be small in diameter and deep, a drill as large as possible should be used, since the boring tool will be a long and springy one necessitating light cuts which will remove the metal more slowly than would the drill. If, on the other hand, the hole is to be of large diameter and not deep, a drill should be used that is only large enough to enable a short, stiff boring tool to readily enter, as the boring tool will remove the stock faster than the drill would. In using the boring tool, it is generally well to feed both ways through the work as this tends to equalize the effect of the wear on the cutting edge. In cases where accurate bores are required, it is quite necessary not to change the depth of cut after the cut has started, as the effect of the spring of the tool will be quite marked. A boring tool tends to make the mouth somewhat larger than the balance of the hole it is boring, because the tool does not take its full spring until the cutting edge passes the end of the base.

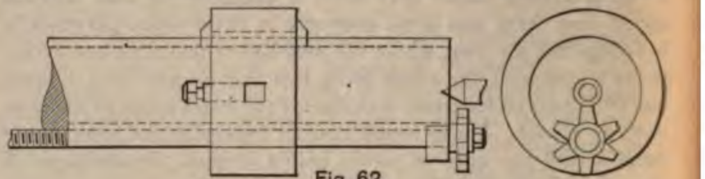


Fig. 62

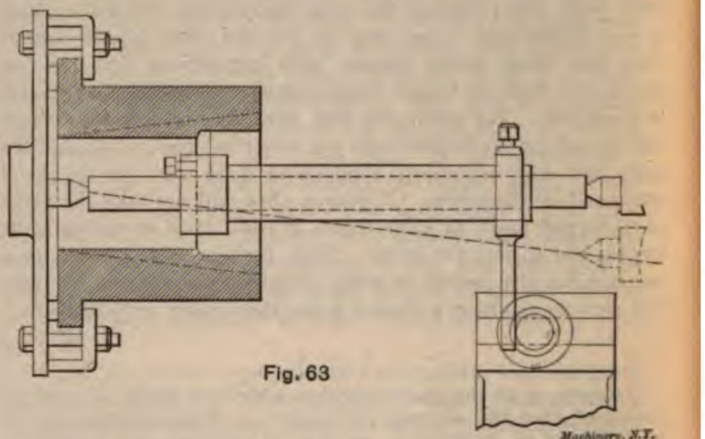


Fig. 63

Machinery, N.Y.

In the boring of parallel holes, the height of the cutting edge does not affect the parallelism of the bore. With tapered bores, however, it is necessary that the tool set at the height of the center, as a different taper than the one required would result if the cutting edge were above or below the center. The amount of taper in either case would be somewhat smaller than when the cutting edge is at the center. When the bores are long and of large diameter, the boring tool is no longer well suited to the work and what is known as a boring bar is used. These bars are of two kinds, those having a cutting tool fixed in its position on the bar, and those in which a cutting tool is screwed in a movable head which traverses over the bar. The former are the least desirable, inasmuch as they must be somewhat more than twice the length of the bore, while, with the latter, a length but slightly greater than the bore is all that is required.

In Fig. 61 is shown a plain boring bar of the former type. The cutting tool may be of flat steel screwed in a mortice through the bar by suitable wedges, or it may be, as shown in the figure, of round steel, fitting nicely the hole through the bar and screwed in position by a set-screw which seats on a flat spot fixed on the tool. The set-screw should have a smooth, flat point so that, when moderately tightened, the tool can be driven under it in adjusting the cut. This class of boring bar is suitable only on work screwed to the carriage, as the work must be given the feed over the cutting tool. In Fig. 62 is shown a traverse head boring bar. A tool-carrying head fits nicely upon this bar. It is splined to receive the key which is screwed in the head. The feed or traverse of the head is accomplished by means of a screw usually driven by a star feed from one end. When the bar is of large diameter as compared with the head, the screw can be dropped into a suitable spline, thus getting it out of the way and protecting it from injury. Boring bars of moderate size are preferably made of a medium grade of tool steel, as this is much stiffer than mild steel. For large bars, mild steel or cast iron is suitable. When cast iron is used, the ends should be plugged with steel to receive the centers, as the cast iron wears too rapidly to retain an accurate center bearing. Movable head boring bars, in which the head is traversed by means of the regular carriage feed, can be used to good advantage in cases where the bar remains stationary and the work rotates. In Fig. 63 is shown a movable head bar of this class operating upon a cylinder secured to the face plate. The bar carries a long sleeve, one end of which terminates in the cutter. A dog or wrench screwed to the outer end of the sleeve prevents it from turning and the tool post bearing against the arm of the dog transmits the regular carriage feed to the tool. By off-setting the tail center as shown by the dotted line, a tapered hole results which will be larger at the inner end of the bore, with the tool set as in the figure, but if the cutting tool is set at 180 degrees from the position shown, the bore will be larger at the outer end, as indicated by the dotted lines.

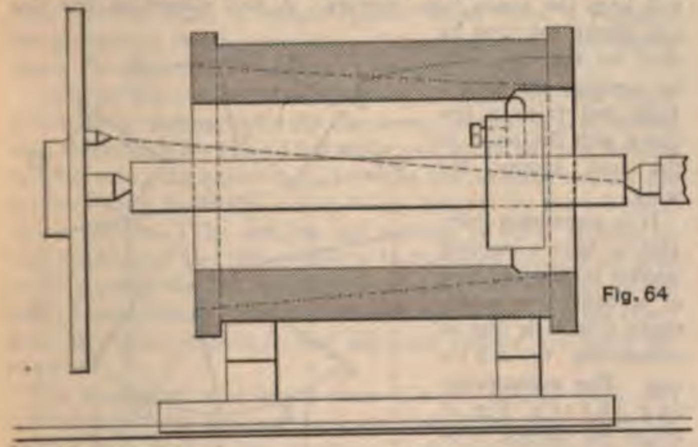


Fig. 64

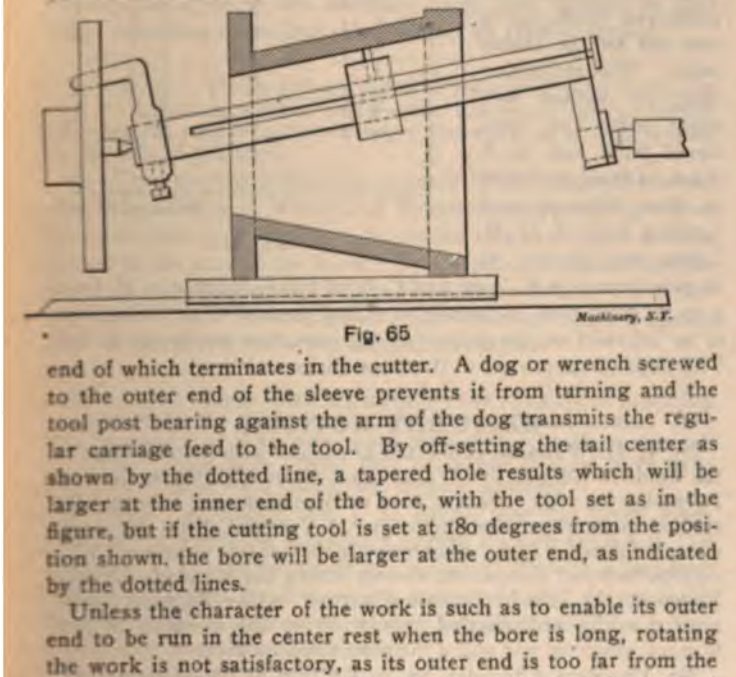

Machinery, N.Y.

Fig. 65

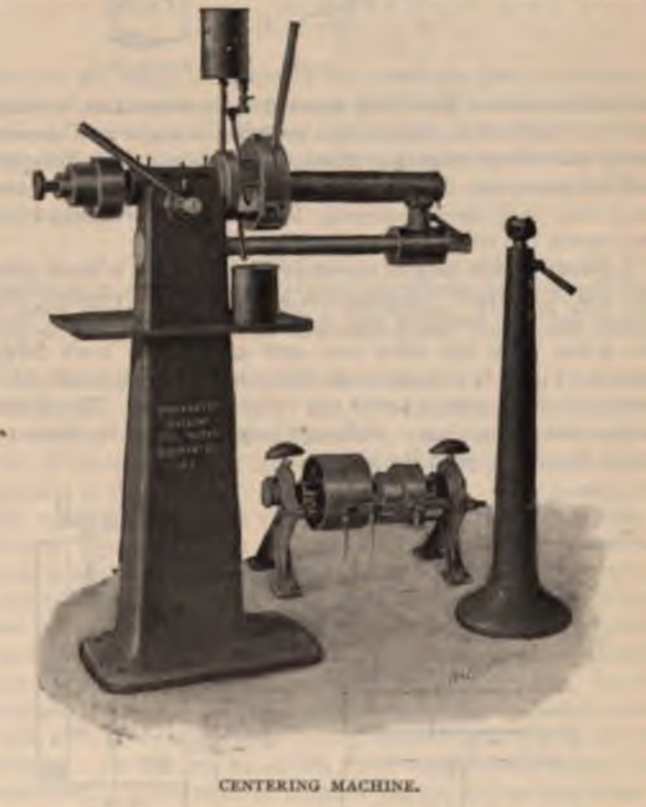
Unless the character of the work is such as to enable its outer end to be run in the center rest when the bore is long, rotating the work is not satisfactory, as its outer end is too far from the lathe spindle to be sufficiently rigid. When the work is clamped to the carriage, it is always preferable to feed the cutting tool rather than the work as the carriage can then be clamped rigidly to the bed. This insures a more accurate bore as the carriage, unless very closely gibbed, will lift on the up cut of the tool.

In Fig. 64 is shown a movable head bar operating upon a cylinder clamped to the lathe carriage. In this case, off-setting the tail center as the bar rotates will not enable the boring of a tapered hole. The tapered hole, however, can be obtained by off-setting one end of the boring bar as shown dotted in the figure. If desired, the offset can be put on the bar itself, in which case it can, as shown in Fig. 65, be offset at the tail center end. By making the center bearing adjustable, as seen in the figure, any desired taper within the limits of its adjustment may be obtained. In boring work, it is very important to see that the work is properly secured on the carriage, face plate or in the chuck. It must be held sufficiently rigid to prevent its working loose and, at the same time, must not be sprung out of shape as, in such cases, when finished and removed from the lathe, it will be found out of true. In straight cylinder boring, more than one cutting tool is usually employed as a single cutter springs the bar, thus requiring very light finishing cuts to produce satisfactory results. Three cutters steady the bar nicely, especially if care is exercised in setting the cuts about equal. A tool for finishing should not follow a roughing cutter, inasmuch as all the springing of the roughing cutter, due to its unequal work at different points of the bore, will be transmitted directly to the finishing cutter and thus produce an untrue cylinder. To insure true work, the finishing cuts should always be light ones.

* * *

## CENTERING MACHINE.

The accompanying illustration shows a new design of centering machine which is intended to center work from ¼ to 3 inches in diameter and of any length. The drill chuck is of special design and is held entirely within the spindle of the machine. The chuck for holding the stock is so located that the work is brought as close as possible to the spindle, making a rigid arrangement for centering stock accurately and especially adapting the machine for centering accurate, finished stock. This chuck is a universal scroll chuck with hardened jaws ground true. The outer end of the work is held by a graduated adjustable rest, which slides on the support bar of the machine. For very long pieces an adjustable rear support is provided which can be placed at any distance in the rear of the machine. It is intended that a combined drill and countersink shall be used, which performs both the operations of drilling and countersinking at once. The drill is held in such a manner that only as much projects beyond the end of the spindle as is used for centering, which makes it possible to center stock that has not been squared up and is either rough on the end or is beveled. A positive stop is provided and any number of pieces can be centered to a uniform depth. The spindle has a convenient lever feed and provision is made for oiling the drill. Each machine is furnished with two drill sockets, one dozen assorted combination center-drills and all wrenches and fixtures required to operate the machine, together with countershaft. The machine is the product of the Binghampton Machine Tool Works, Binghampton, N. Y.


CENTERING MACHINE.

## SHOP KINKS.

**A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.**
**Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.**

### SOME LATHE AND PLANER KINKS.

Mr. Edward G. Haddix, Burlington, Iowa, sends sketches with descriptions of some useful lathe and planer tools and attachments. Fig. 1 is a finishing tool for planers, which may be used on either steel or wrought iron without water and leave an excellently finished surface. The tool is forged from ordinary stock, but the cutting portion is made diagonal to faces of stock so that when used the edge A operates with a shearing action. Mr. Haddix states that the cutting edge should be ground with a lip and the end rounded slightly, so that only a small portion of the end will bear on the work, but we believe the practice, where these tools are used, is, in some cases, to make the tool with the cutting edge perfectly straight and merely round the corners slightly. Planer tools made on this principle require great care in the setting to obtain good results, and must also be ground accurately, but the surfaces obtained are well worth the trouble.

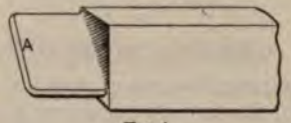
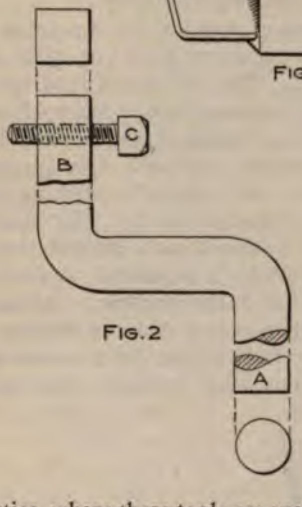
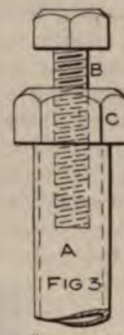


FIG. 1





Machinery N. Y.

A planer dog or jack is shown in Fig. 2, which is made with the end A of round cross-section and the end B square. The round end may be stuck into a hole in the planer platen, and the screw C in the other end used against the work being planed. Fig. 3 is a planer jack that can be quickly made from a section of gas-pipe, a screw and an ordinary nut. The sketch makes everything clear. Although very simple, it is, however, handy to have around the planer.

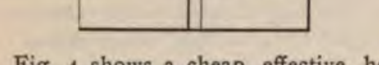


FIG 4

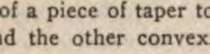
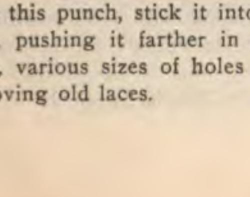
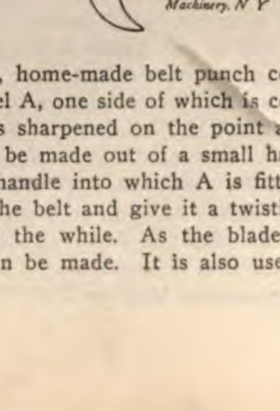


FIG. 5





Machinery, N. Y.

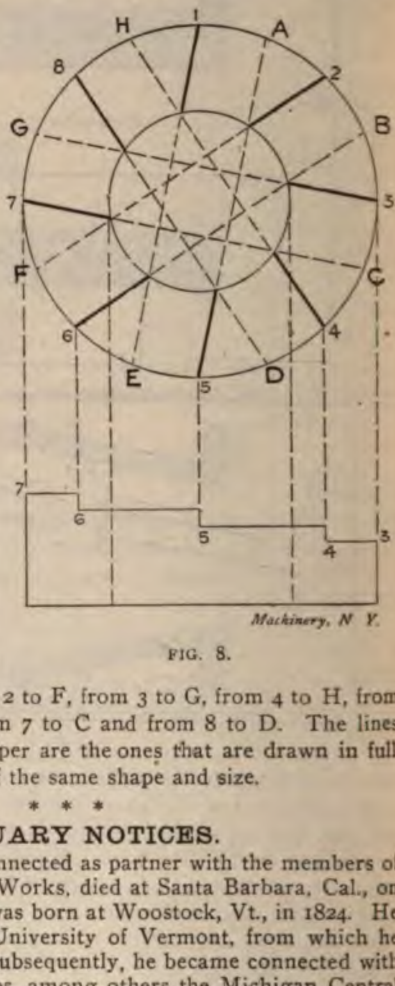
Fig. 4 shows a cheap, effective, home-made belt punch consisting of a piece of taper tool steel A, one side of which is concave and the other convex. It is sharpened on the point and on the two edges and can easily be made out of a small half-round file. B is a common file handle into which A is fitted. To use this punch, stick it into the belt and give it a twisting motion, pushing it farther in all the while. As the blade is tapered, various sizes of holes can be made. It is also useful in removing old laces.

Fig. 5 represents a heavy cutting-off tool used for cutting large shafts and bars. It is made in the usual manner except that there is more metal in the thin part, bringing the edge C below the line of the shank of the tool. When it is being used, a small jack is set on the cross-slide of the lathe carriage, and this blocks up the portion marked C, thus adding to the stiffness of the tool.

We had some countersunk head rivets to make out of copper wire and found it difficult to hold the wire until a head could be formed. This is the way we overcame the difficulty. A couple of pieces of ½"x1½" flat-iron were procured, clamped together and drilled so that the hole came in each piece, as in Fig. 6. Then the hole was countersunk, the wire was held between these plates, which in turn were held in the vise and the rivets were made quickly.

Oftentimes in planer work, the tool, when at the end of a stroke, will break out a large piece of metal. This usually happens when the cast-iron is dirty, and in order to prevent this, a man will have to score a line with a hammer and chisel. Even then it is not always a good job, and it takes considerable time. Fig. 7 is a planer head, having a small hole about ⅝" tapped in the side through to the apron, as shown at D in the sketch. This hole is fitted with a set-screw, having a flat point, which will keep the apron from moving. A tool something like the one shown can then be used for scoring a line by running the head back and forth a few times with the point of the tool against the work.

It is sometimes desirable to have a stepped washer for the tool-post of a lathe, but sometimes trouble is met in attempting to make one. The accompanying sketch, Fig. 8, shows the method to be employed when laying one out for the shaper man. The circumference is divided into eight parts and numbered from one to 8. Each of these divisions is then bisected and lettered from A to H. Lines are drawn, as shown, from 1 to E, from 2 to F, from 3 to G, from 4 to H, from 5 to A, from 6 to B, from 7 to C and from 8 to D. The lines to be followed on the shaper are the ones that are drawn in full. The steps or spaces are of the same shape and size.



Machinery, N. Y.

FIG. 8.

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## OBITUARY NOTICES.

Dr. E. H. Williams, connected as partner with the members of the Baldwin Locomotive Works, died at Santa Barbara, Cal., on December 21, 1899. He was born at Woostock, Vt., in 1824. He studied medicine at the University of Vermont, from which he was graduated in 1846. Subsequently, he became connected with various railroad companies, among others the Michigan Central Railroad. In 1870 he became a partner in the Baldwin Locomotive works and traveled extensively in the interests of that firm, of which he was still a member when he died.

Mr. Theodore Alteneder, Sr., of the firm of Theodore Alteneder & Sons, manufacturers of drawing instruments, died recently in Philadelphia, aged 78 years. Mr. Alteneder's inventions and improvements have made his name familiar to the engineering profession.

Mr. Samuel Dana Greene, assistant general manager of the General Electric Co., Schenectady, N. Y., was drowned with his wife while skating on the Mohawk River. He was the son of Commander Samuel Dana Greene, U. S. N., and was one of the foremost men of Schenectady and well known all over the state. Mr. Greene was for some years chief engineer of the Sprague Electric Railway and Motor Co. His wife was a daughter of Rear Admiral Chandler, U. S. N.

## HOW AND WHY.

### A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

**Give all details and name and address. The latter are for our own convenience and will not be published.**

34.—H. W. R.: Do you know of any practical way of soldering aluminum?

A.—The answer to this question was taken from the catalogue of the Pittsburg Reduction Co.

Good joints can be made by carefully cleaning the surfaces to be joined and, with very hot soldering bits or careful work with the blow pipe, "tinning" the surfaces with some of the special solder used, before attempting to join the surfaces of the metals, using special alloys for the solder. Several such solders are successfully used, pure tin with a little phosphor tin being the basis of the majority of such solders. Soldering bits of nickel are best, however, and specially good work has been done with those kept hot by a gasoline torch or electric appliance.

Special care should be taken to clean the surfaces to be soldered. This can be successfully accomplished by the mechanical means of scratch-brushing, scraping or filing the surfaces, thus exposing fresh metal free from the thin film of oxide of aluminum and the oxide of silicon (silica) which forms a retentive and protecting coating over the surface of the metal, preventing either the soldering or plating of the aluminum.

Another way to clean the surface of aluminum, for either soldering or plating, is to dip the sheets into nitric acid diluted with three times its bulk of hot water and which has just enough hydrofluoric acid added to it to make the solution act on the surface of the metal, this action being denoted by the evolution of gas bubbles. The solution can be kept in either wooden or lead lined tanks, and the amount of hydrofluoric acid added need be only small, say less than five, or at most, ten per cent. of the bulk of the solution. The hydrofluoric acid required is the cheap fluid of commerce sold in lead jugs and costing five cents per pound.

The aluminum, after being cleaned in this diluted nitric and hydrofluoric acid solution, is again dipped into hot water for rinsing and dried in hot sawdust. It is then cleaned so that either soldering or plating solutions can be readily applied.

35.—M. L.: Please tell me which is the correct way to set the tool in threading a taper piece—with the center line of thread tool at right angles to the surface of the work, or at right angles to the axis of the work.

A.—The accepted method, as reported by the committee of the American Society of Mechanical Engineers, appointed to report upon standard pipe threads, is to set the axis of the tool at right angles to the axis of the work. This practice is commonly followed by tap manufacturers. On steep tapers threads cut in this way have greater holding power. On ordinary tapers it makes little or no difference which method is adopted.

36.—A. D.: There is an argument in our shop about punching steel of the same thickness as the diameter of the punch. Can this be done, and if so, how much thicker than this can a punch penetrate? One man claims that 12 inches of steel have been punched at once by a punch one inch in diameter.

A.—Our contributor, Mr. J. L. Lucas, who has given much attention to punching machinery, writes us with regard to this question: "The punching of 2½ inches of steel by a one-inch punch is the best that I have any record of and I do not think that 12 inches of either iron or steel can be punched by a one-inch punch under any conditions."

37.—We have received two inquiries from foreign correspondents, one about a pyrometer known as "Hobson's Pyrometer" and the other with regard to hardening Bessemer steel or Homogene.

A.—We are unable to obtain any information about a pyrometer by this name and must refer the question to our readers. With regard to hardening the steel, Mr. Maunsel White, engineer of tests, Bethlehem Steel Co., writes: "We do not know of any special process for hardening Bessemer steel or Homogene. The presence of carbon is essential to hardening and it can be very readily aided by means of cementation."

38.—W. H. M.: 1. What metal expands the most? 2. How much would a hollow cylinder of this metal expand, if it were 1" × 1" × 3/16" shell? 3. How can I calculate the size of a steam engine (without the use of a formula) to drive an air compressor or any given machine?

A.—1. Of the common metals, lead and zinc; and as far as we know their expansion exceeds that of any metal. Aluminum expands nearly as much. 2. The coefficient of expansion is about .000015 for each degree Fahr. The temperature of a gas flame would probably not be far from 1000 degrees, although we know of no tests showing just what it is. The expansion of a hollow cylinder depends upon the expansion of its diameter and not the expansion of its area. Hence this cylinder would increase about 940 × .000015 × 1 = .014 inch, assuming the temperature at the start to be 60 degrees. 3. To determine the size of a steam engine we must know the power it is to develop, the number of revolutions it is to make, the mean steam pressure in the cylinder and the relation between the length of stroke and the diameter of cylinder. The mean steam pressure will depend mainly upon the boiler pressure, the point of cut-off and the amount of compression. In the computation the area of the cylinder must be taken in inches and the length of stroke in feet. The relations between all these quantities are complex and can be much more easily found by the aid of formulas, which are quite simple and which we should advise you to learn to use. In fact, we could not well spare the room necessary to explain the question without the aid of a formula. The simple formula for the horse power of a steam engine is

$$H = \frac{2 \times P \times L \times A \times N}{33{,}000}$$

where H = horse-power, P = mean effective pressure, L = length of stroke in feet, A = area of piston in inches, N = revolutions per minute. For your particular problem this can be reduced to the form,

$$L \times A = \frac{16{,}500 \times H}{P \times N}$$

That is, the length of stroke in feet, times the area of cylinder, equals 16500 times the horse-power, divided by the mean effective pressure times the number of revolutions per minute. Your main difficulty may be in determining the mean effective pressure and for a rough estimate this may be taken at half the boiler pressure.

39.—L. M.: 1.—What is the rule to find the angle of a tool for cutting very coarse square threads? 2.—Please outline a course of study most likely to benefit a toolmaker. 3.—Will you not publish something upon die construction and mechanical drawing?

A.—We did not notice, until too late for this issue, that your first enquiry needs a sketch. We will, however, try to explain the subject without a drawing. First, compute the circumference of the screw at the base of the thread, by multiplying the diameter at the base by 22 and dividing it by 7. Draw a straight line, which we will call a b, equal to the length of this circumference. From point a at one end of the line, draw another line at right angles to it of a length equal to the pitch of the screw. Connect the outer end of this second line with point b of the first line, making a right-angled triangle. This last line gives the inclination of the thread, and the side of the tool should have a little more clearance or inclination than this line. 2.—A toolmaker should try to lay a good foundation on which he can build with future knowledge from whatever source it is to be obtained. To this end he should know enough mathematics to understand the articles in the technical papers, and we can recommend for this purpose "Mathematics Self-Taught," which is noticed in another column of this number. It would be well to procure the book on the milling machine published by the Cincinnati Milling Machine Company, and by the Brown & Sharpe Manufacturing Company, as well as the books on grinding machines and gearing published by the latter firm. Other subjects that would be of value are elementary mechanics, mechanism and mechanical drawing, and the subject of steel. There are several excellent books upon all of these, which we shall be pleased to name, if desired. A toolmaker needs to be a close student of the ways and means of doing shop work, and hence should be a close observer and a careful reader of the mechanical papers, and lacked the time and possibly the knowledge necessary to make a it would also be well to study the different catalogues as they appear. We know of no good book treating strictly of tool making. 3.—We shall be pleased to receive material upon die making from any reader of MACHINERY who has had experience in this line of work. A complete series upon mechanical drawing was published in the second volume of MACHINERY.

40.—Clayton: 1.—How much oil does it take to produce 1 H.P. in an oil engine? 2.—How much gas does it take to produce 1 H. P. in a gas engine? 3.—How do they calculate that air is compressed to 35 atmospheres as in the case of the Diesel motor? 4.—Is this type of motor more economical than any other?

A.—1.—Tests of a number of oil engines of 10 or 15 H. P. show oil consumption of from ½ to 1½ pounds per H. P. hour. 2.—Small gas engines use from 25 to 30 feet of gas, medium sized gas engines, 18 to 25 cubic feet, and large engines from 12 to 18 cubic feet per H. P. hour (indicated). 3.—When a gas of known volume is compressed to a smaller volume, its temperature and pressure rise according to certain known laws and they can be approximately calculated. The formula that would apply to the Diesel motor is:

$$\frac{v}{V} = \left(\frac{P}{p}\right)^{1.41}$$

where v, p are the volume and pressure at the beginning of compression and V, P are the volume and pressure at the end. To compress to 35 atmospheres would probably require that the air be compressed to about 8-10 of its original volume. This formula requires the use of logarithms in its application. 4.—The Diesel motor is said to operate on about 4-10 pounds of oil per H. P. hour.

41.—A. H. I.: Could you give the best method of magnetizing a piece of tool steel? The piece is small, about 3 inches long and ¾ inches square, and is for experimental purposes. I have attempted to magnetize it in several ways, but it takes very little, merely enough to pick up a small needle, and it seems that I have not the right temper in it.

A.—The best way to magnetize a piece of hardened steel is by means of an electric current passed through a coil of wire wound around the bar. Make a spool, about the length of the bar, and of sufficient diameter to hold about 1000 feet of No. 20 B. & S. cotton covered magnet wire. Take a piece of bar iron about one inch square and bend it into the form of a U and of such size that it will span the coil and pass over the ends of the steel bar, so as to form a closed loop with the steel. Pass through the coil a current derived from the wires leading to an incandescent light socket. Do not allow the current to pass through the coil for more than two or three seconds or it will burn it out. After the current has been cut off, remove the U bar and take out the magnet, and if it is of the proper kind of steel and suitably tempered, it will be well magnetized. Any good quality of tool steel will make a strong magnet, although some kinds are better than others. Chrome steel is very good. The bar should be hardened in ice cold brine, and then it should be drawn to a very light straw color.

42.—G. E. R.—I am running an Eddy generator of 15 K. W. capacity, which gives an e.m.f. of 125 volts and current of 120 amperes. When the machine stands still for 10 or 12 hours, it sparks badly on starting up, then after a few minutes it runs all right until it stands still again. The commutator is a little rough and I cannot keep it smooth. The machine is run at 110 volts and the ammeter stands at 128 amperes, and when I put on all the lights, the brushes have to be moved forward. I would like to know how to stop the sparking and also whether it will do to add 20 more lights, of 16 candle power each.

A.—When the generator stands still for some hours, dust collects upon the surface of the commutator, and as it is not very smooth, this dust does not rub off readily, hence, the sparking is increased in starting, until the dust is removed by the rubbing of the brushes. There is evidently nothing the matter with the machine, and the only way to reduce the sparking is by moving the brushes back and forth until the position is found in which they make the smallest spark. In this way the surface can be kept smoother, for the smaller the spark the less it is roughened up. Theoretically, the brushes of all generators have to be advanced as the strength of current increases, but some generators are so proportioned that the amount of shifting required is so small as to amount to nothing, practically, unless the machine is greatly overloaded. As to the advisability of adding 20 more lamps, we can only say that a machine of the size given should be able to carry 240 to 250 16-candle lamps at full lead, and an increase of 20, which would be less than ten per cent., should not overtax it. On general principles it is not good policy to overload machines, because one is likely to wind up by following the practice of street car conductors who always believe there is room for one more. Thus if you start by adding 20 lamps you may next try the experiment of increasing the number by ten, and then another ten, and so on until the generator breaks down under the load.

* * *

## NEW TOOLS OF THE MONTH.

**Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.**

Chicago Flexible Shaft Co., Chicago, Ill. A gas blast furnace which combines a complete outfit for hardening, tempering and annealing dies, taps, reamers, drills and similar tools.

National Die Stock Co., Cleveland, Ohio. A die stock that contains some convenient features. It is adjustable and has a quick-acting motion for opening the two-part die.

Carter & Hakes Machine Co., Winsted, Conn. A plain milling machine that contains a number of valuable features. Has reversed cone pulley so that additional strength is obtained in the frame supporting the work spindle.

William H. Warren Machine Tool Works, Worcester, Mass. A 4½ foot semi-universal radial drill of extremely heavy pattern. Contains some features not possessed by the older models.

J. L. Cook, Springfield, Ill. A drill socket made so as to prevent the twisting off of shanks that is so common with the ordinary type.

Marshall & Huschart Machinery Co., Chicago. A circular saw for machine shops, intended to take the place of the older style power hack saw.

Fellows Gear Shaper Co., Springfield, Vt. Improvements in the 36-inch Fellows gear shaper.

* * *

## FRESH FROM THE PRESS.

The Mechanical World Pocket Diary and Year Book, for 1900. Thirteenth year of publication. Published by the "Mechanical World," Manchester, England. Price in England, sixpence.

This book has 244 pages, pocket size, and contains a collection of engineering notes, rules, tables, and other data, and is one of the better known handbooks. As it is quite small and compact it covers the field of mechanical engineering only in a limited way, but at the same time it is a useful book and treats, among other subjects, of steam and the steam engine, the steam engine indicator, slide-valve diagram, gas engines, boilers, safety valves, strength of materials, gearing, rope driving, and has numerous tables upon various subjects. While the book does not cover the same ground, it is of about the size and grade as that issued by the International Correspondence Schools in this country. It is devoted more strictly to engineering and mechanical matters than the latter.

Fowler's Mechanical Engineers' Pocket Book, edition of 1900. 500 pages, illustrated. Edited by William H. Fowler, and published by The Scientific Publishing Co., Manchester, England. For sale by D. Van Nostrand Co., Murray street, New York. Price $1.00.

We have been favored with a copy of this work by both the publishers and their representatives in this country. The first edition of the pocket book was noticed in these columns when it appeared a year ago, and this new edition is increased to nearly twice the size of the former one. To give an idea of its scope it may be said that it is larger and treats of more subjects than the "Mechanical World" pocket book, mentioned above, but that it is not as complete as Low's pocket book, which is a well known English work. It also treats less of design and more of general principles. It is made up largely of bits of valuable information about engineering that have been obtained from various sources and treats of some subjects, like textile machinery, for example, that most hand-books are silent upon.

Power Transmitted by Electricity, by Philip Atkinson, A.M., Ph.D. Published by D. Van Nostrand Co., 23 Murray and 27 Warren streets, New York. 241 12mo pages, illustrated. Price $2.00.

Mr. Atkinson has written several books upon electrical subjects that have been of value to the reader desiring a general and somewhat superficial knowledge of the subject, but who gh study of it. The present volume is a complete revision ok written by the author several years ago upon the trans- ion of power and it has been his aim to bring it up to date espects. As stated, it does not go into the subject deeply, ats in a popular, but we believe in an entirely accurate, r of the electric motor, for both stationary and railway and central station construction and equipment.

dard Polyphase Apparatus and Systems, by Maurice A. M.S. Published in England and for sale by D. Van Nos- Co., 23 Murray and 27 Warren street, New York. 250 illustrated. Price $3.00.

book seems to fill a corner in the field of electrical litera- at will be appreciated by the student and the practitioner The increasing use of the alternating current has made it ry for those connected with the electrical industry to be- nformed as far as possible about its operation. There is literature upon the subject, but it is generally of an in- mathematical character and there has seemed to be no le information in a more popular style. The author states s work is for those who operate or are interested in poly- machinery and that while a general acquaintance with ting current machinery and apparatus is presupposed, he s that those who have had experience only with direct machinery will be able to understand his work. The book o elementary as those of Mr. Atkinson's mentioned above, longs rather to that class that stands between the popular ent and the mathematical treatment found in the most ad- books.

ematics Self-Taught. Arithmetic and Algebra. Adapted he German of H. B. Lubsen, by Henry Harrison Suplee, Published by the author, 120-122 Liberty street, New 338 8vo pages. Price $2.00.

subjects of arithmetic and algebra are here treated by ds that are quite different from those adopted by American s in their school text-books. It is less abstract and the re more fully explained, with the evident intention of lead- student step by step to a complete understanding of the . The section on arithmetic is confined strictly to its sub- d does not contain matter, like mensuration and other that properly come under the heading of geometry or ranches of mathematics. The Lubsen method is to be nded in several respects. For example, the student is led unconsciously from arithmetic to algebra and he finds working with literal factors instead of numerals without g that he is doing anything outside of the realm of ordi- rithmetic. The same is also true when the subject of hms is taken up. Hrere the student finds a simple expla- of how calculations can be simplified by tables of ex- s, which are really logarithms, and when he is convinced is can be done, he is ready to take up problems in loga- with an understanding of the basis on which they are l.

e the subject matter is presented clearly, the book is not tary in the sense of being incomplete or only adapted to e of younger pupils. Sufficient ground is covered for al purposes and of the two the work is better suited to who wish to become more proficient in mathematics young beginners. Many examples are worked out to he process of applying arithmetic and algebra to actual Some of these examples have a very practical bearing in ics. The book abounds in interesting features that will appreciated, perhaps, by those who are accustomed to the ext books. One of these is a simple approximate method tracting roots, and another is the explanation of why ons are indicated and not performed in algebra.

arn mathematics, like any other difficult subject, requires, student who is studiously inclined and is accustomed to and a great deal of time devoted to the subject. It is as a trade to be able to sit down and master a book as to n a good piece of machine work. If one is studiously in- we believe that he can learn a great deal about mathe- from this book, and we can recommend it to such a person ne study, without a teacher.

## ADVERTISING LITERATURE.

NDARD SIZES FOR CATALOGS ARE 9 X 12, 6 X 9 AND 3½ X 6 INCHES. E 6 X 9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

D. Watkins, 9-15 Murray street, New York, has issued o number of the Bradford Diary which is intended for use. It is an attractive little book and, for those who do h to keep a diary, it serves as an excellent daily reminder.

Grant Machine Tool Works, Cleveland, O. Catalogue of e tools and of steel balls and screw machine products y the Grant Ball Co.; 32 pages illustrated.

company is gradually adding to the list of tools that it one of the latest additions being a 44" turret and chuck- e. There are also several small machine parts illustrated, ompound rest, milling machine vise, etc.

The Standard Tool Co., Cleveland, O. Catalogue of twist drills, reamers, taps, etc.; 79 pages illustrated.

The well-known line of small tools made by this company has been added to during the past year, making the list of their products and the variety of sizes and styles more complete than ever before.

W. H. Nicholson & Co., Wilkesbarre, Pa. Catalogue of expanding lathe mandrels, 18 pages illustrated.

The utility of these expanding mandrels for lathe and milling machine work is well known, and the catalogue gives full information about the different sizes and styles in which they are made and their use.

H. H. Franklin Mfg. Co., Syracuse, N. Y., have issued a small catalogue that shows in an attractive manner some of the numerous castings that they make to take the place of parts that are ordinarily machine finished. The process used by this company is said to be such that screw threads and other parts can be cast which are as good for many purposes as the same parts finished by machine.

Prentiss Vise Co., 44 Barclay street, New York. Catalogue of vises, 48 pages illustrated.

The numerous styles of vises made by this company are listed in this catalogue and include, besides their numerous types of machinists' vises, many special designs.

The Billings & Spencer Co., Hartford, Conn. Catalogue of improved dropped hammers, trimming presses and forges; 36 pages illustrated.

Drop hammers ranging from 3000 pounds weight of drop to a 400 pound hammer are listed, and photographs are shown of numerous drop forgings regularly made by this company.

## MANUFACTURERS' NOTES.

It is the evident intention of the Joseph Dixon Crucible Co., Jersey City, N. J., that if the work of the editor for the coming year is of an inferior quality, it shall be through no fault of theirs. With their customary generosity they have presented us with a varied assortment of pencils and erasers for the New Year. These, it is needless to say, are of superior quality, and, if the tools could make the man, or more properly, in this case, the periodical, the readers would join with us in extending thanks to the well known makers of these excellent pencils.

The International Correspondence Schools now announce that they have over 130,000 students and that their courses number over 70.

The B. F. Sturtevant Co., of Boston, Mass., report an increase of nearly 40 per cent. in the volume of their business for 1899 over that of the previous year.

During the past year an addition covering 20,000 sq. ft. has been made for the use of the electrical department, which although completed a few months ago, is, they say, already overcrowded. They also report numerous special orders for electric fans and special generating sets for the Navy Department, and the construction of a complete line of enclosed motors of new design is now under way.

The old method of running belts tight has been so long forced upon engineers that they are often slow to realize that slack belts, carrying full load and running free of initial tension yet never slipping, are not only a mechanical possibility,. but an actual condition seen in shops of the customers of the Cling-Surface Mfg. Co., Buffalo, N. Y., whose business about New York has necessitated the opening of a branch office in that city, in the Postal-Telegraph Bldg., 253 Broadway.

The Waltham Watch Tool Co., Springfield, Mass., have recently added to their works a new shop about 25,000 square feet, which is about three times the area of their old shop.

Mr. Charles A. Moore, of Manning, Maxwell & Moore, New York City, sailed on Tuesday, January 9, for Mediterranean ports and Egypt. The trip is said to be purely one of rest, and no business is to be connected with it.

The Pedrick & Ayer Co. have sent fifty-two of their belted shop air compressors abroad during the past year.

The Newton Machine Tool Works have made an addition to their present shop to accommodate their increasing business. The addition will make a shop 100′ by 222′.

The Stow Flexible Shaft Co., of Philadelphia, had recently a request from one of the largest fruit growers of Southern California, for an equipment of their flexible shafting so arranged as to be of value attached to a motive power, for tree trimming. Mr. Frederick Schoff, proprietor of this company, at once set about making such equipment, and reports evidence of much success therein. They also report a large increase of orders for their portable air motor.

The Sprague Electric Co. of New York have just received an order for sixteen motors to be used in running the presses and machinery in a lithographing establishment in Tokio, Japan. It will be one of the finest equipped plants in Japan and will be operated under the supervision of a Japanese expert who is now in this country gathering ideas.

### CALENDARS.

We have received from the Standard Welding Co., Cleveland, O., a calendar and memorandum book which calls attention to this company's electrically welded specialties.

The Eagle Oil & Supply Co., Boston, Mass., have sent us several of their calendars for the year 1900 which have fine and appropriate illustrations for each succeeding month.

We are also in receipt of a handsomely illustrated calendar from the Standard Tool Co., Cleveland, O.

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WANTED.—Copies of MACHINERY, issue of January, 1898. State price. Address,
THE INDUSTRIAL PRESS, 9-15 Murray Street, New York.

WANTED.—Back numbers of MACHINERY. Will pay liberally for the following numbers: Vol. 1, No. 2; Vol. 2, No. 11; Vol. 3, Nos. 1, 2, 4, 6, 8, 9 and 10, or will buy whole of Vol. 3; Vol. 4, No. 5. CHAS M. SHAW, Hagerstown, Md

WANTED.—Young man who is thoroughly posted on names and location of machinery manufacturers and other points necessary for catalogue work. Address, stating experience and salary desired, PERMANENT, care of MACHINERY, 9-15 Murray Street, New York.

A BELT LACE PATENT FOR SALE.—No holes in belt, no riveting or glueing, but a one piece metal that will hold the tightest belt and operate satisfactorily at the highest speed. The slack can be taken up instantly. I have no time to manufacture this article, but there is a fortune in it. Write quick and get full particulars and a sample. MICHAEL PARIDON, Box 96, New Portage, Ohio

WANTED.—A small novelty that will sell through the mail. Send full particulars to MANUFACTURER, care of MACHINERY, 9-15 Murray Street, New York.

WANTED.—Mechanical engineer to take charge of machine shop for building all kinds of machines. Must be draughtsman. State past experience. Address S. M. G., care of MACHINERY, 9-15 Murray Street, New York.

WANTED.—Three thoroughly experienced machinery blacksmiths, accustomed to working to drawings; also one foreman blacksmith capable of handling forty men on general work including high class machine forging. Address "B," care of MACHINERY, 9-15 Murray Street, New York.

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A Barrel of Gold

represents the savings of a generation; but a barrel of lubricating oil can be accumulated in a very short time by saving a little each day. Don't think because you use only a small quantity of oil that it isn't worth saving. Keep a barrel in the corner, out of the way; put your waste oil in it every day or two, and you'll be surprised how soon it will fill up. Then run it through your Warden Filter and you will have a barrel of oil as good as any you can buy. If you think this is too small to bother with, just figure up what even one quart of oil saved each day amounts to in the course of a year. Why should you throw away 75 gallons of good oil?

*"A Paying Investment."*

THE BURT MFG. CO., Akron, Ohio.
GENTLEMEN:—The third Warden Oil Filter just received from you has not yet been put into commission, but the other two filters we are using in our flooring plant and Mill No. 2 have given us entire satisfaction, and that is the reason why we ordered this third filter for mill No. 1. As yet we have had no reason to regret the placing of these filters in commission as we think they are a paying investment, and they surely do their work in good shape.
Yours truly, COBBS & MITCHELL,
Cadillac, Mich.

A Warden Filter costs more to make and is the cheapest in the end, so that it's no economy to buy a cheap and worthless imitation. Write us for price on a small Filter. We make big ones too.

The Burt Manufacturing Co., Main & Howard Sts., Akron, Ohio, U. S. A.
LARGEST MANUFACTURERS OF OIL FILTERS IN THE WORLD.

Ten years on the market. Acknowledged everywhere as the standard. Used in 26 countries, adopted by 6 Governments. Ask your oil company or supply house to send you one on approval. Carried in stock by Shelby & Co., London, Eng., Alfred Stucken, Moscow, Russia, and Gustav Diechmann & Sohn, Berlin, Germany.

# MACHINERY.

Vol. 6. March, 1900. No. 7.

## AS SEEN BY A DESIGNER.

### THE GENESIS OF MACHINE DESIGN, WITH APPLICATIONS.

W. H. SARGENT.

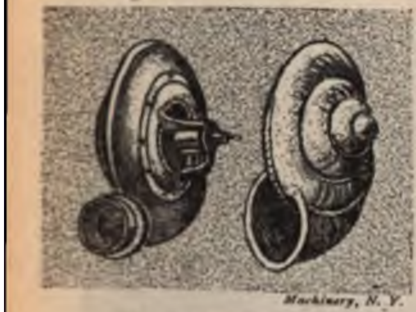

Machinery, N. Y.

Fig. 1. Applied Zoology.

THERE is a theory that the human mind is like the cylinder to a phonograph, recording indelibly every impression made upon it and capable of reproducing them at will. Sometimes these impressions assert themselves when not called upon and many a speaker or writer has quoted the sayings of others under the delusion that the thoughts were his own. Draughtsmen and designers being human, are alike subject to the vagaries of the human mind. Many times, in designing a piece of machinery, a certain form will persistently assert itself to the draughtsman. Whether this suggestion be perfectly suitable or wholly impracticable, the mind finds itself constantly reproducing some impression made upon it at a previous time, and especially is it true that we unconsciously copy natural objects which often have little in common with the matter in hand.

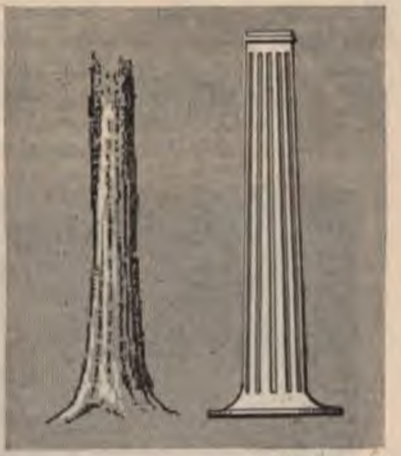

Machinery, N. Y.

Fig. 4. The Trunk and Pillar.

#### Influence of Natural Forms.

Take for example, a rotary fan or blower and one is so struck with the resemblance to a snail shell as to warrant the belief that the designer was familiar with such shells and has recognized the suitability of the design as a guard to cover delicate and easily injured parts. There could hardly be greater contrast than between the swiftly revolving fan and the slow moving snail, yet it is difficult to resist the impression that the shell had somehow unconsciously influenced the mind of the designer. This resemblance is shown in Fig. 1.

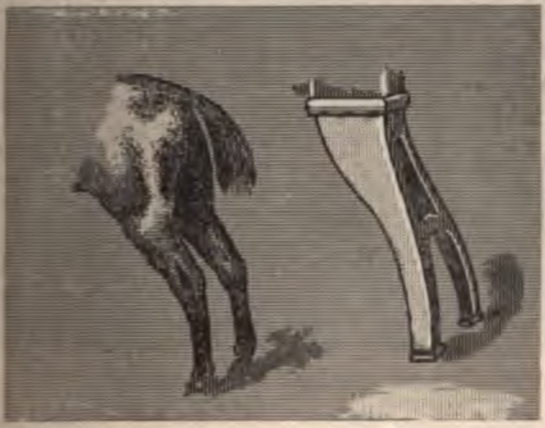


Fig. 2. Horse Legs.

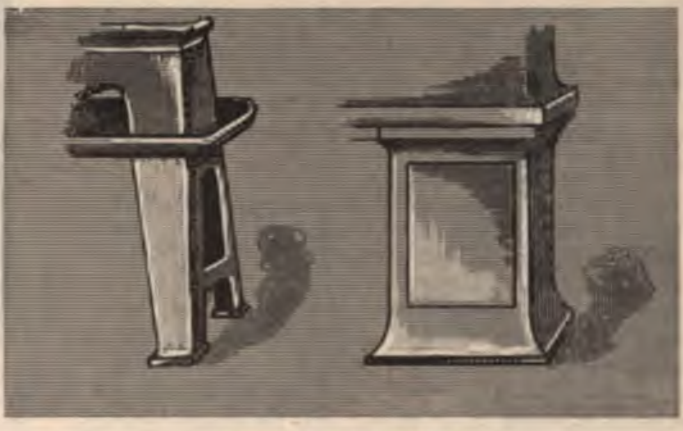


Fig. 3. "Horseless" Legs.

For convenience in use, machine tools must be mounted at a certain height above the floor and the intervening space filled in with something which, as Abraham Lincoln said of his legs, "should be long enough to reach from his body to the floor." Now, I have many times heard draughtsmen say that the hardest thing to design about a machine was a suitable leg. The reason is obvious—a leg is inappropriate, a support is what is needed. We get the idea of legs from the animals which we see about us every day, forgetting that these legs are used for traveling rather than for standing still. Such legs may not be so inappropriate for furniture or movable articles as for a machine tool which should be the very embodiment of stability. Here again the doctrine of unconscious suggestion appears in the resemblance to the legs of some animal as the horse, Fig. 2. The double curved "bandy" leg may still be acceptable on chairs, cabinets or pianos, but on machine tools it is being replaced by a more rigid support in which the idea of a leg is quite abandoned, one of the most popular and appropriate styles being the cabinet, Fig. 3.

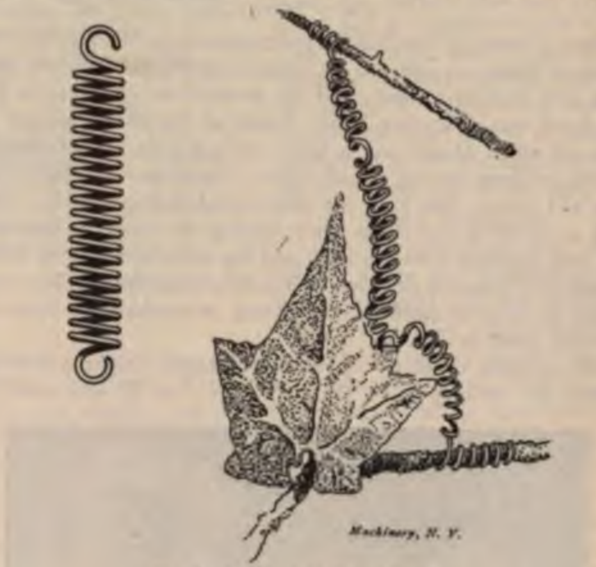

Machinery, N. Y.

Fig. 5. Origin of the Spiral Spring.

Pillars are usually admissible in machine design and here again the idea is suggested unconsciously, a pillar being the conventionalized form of a tree trunk, the flutes in the pillar being modified from the ridges of bark and the curving base being caught from the spreading of the roots, Fig. 4. The tree trunk is made to stand and is designed to support something and is therefore a logical model to follow when these qualifications are desired. The pillar lends itself well to architectural purposes and has been fluted and decorated to a point not permissible in machine design.

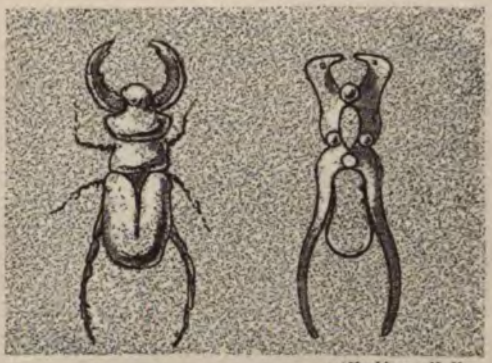

Machinery, N. Y.

Fig. 6. Nippers.

Who invents all the little simple appliances of everyday life? Many of them are adapted by human nature from nature itself. Pins and needles we get from the thorn tree; perhaps the first fish-hook was a herring bone. Look at the coiled spring! It was old when Moses was a boy. Go out into the garden and watch for them on the squash vines. Examine one closely and you will notice that it is not only coiled, but coiled two ways with a device in the center for reversing the twist, so that with one end growing from the stalk and the other attached to a twig it may still continue to twist. Here is an unpatented idea which might perhaps be profitably employed in mechanics. Note the reversed twist in Fig. 5.

The nippers of some varieties of beetles might have suggested the cut-nippers of the shop (see Fig. 6) and other insect workmen might teach us secrets in the arts of the weaver, paper-maker, plasterer or mason. We speak of a suspension bridge as a "spider's web," but really the bridge builder "isn't in it" as compared with the spider. His is the

> "Knowledge never learned of schools,
> For, eschewing books and tasks,
> Nature answers all he asks."

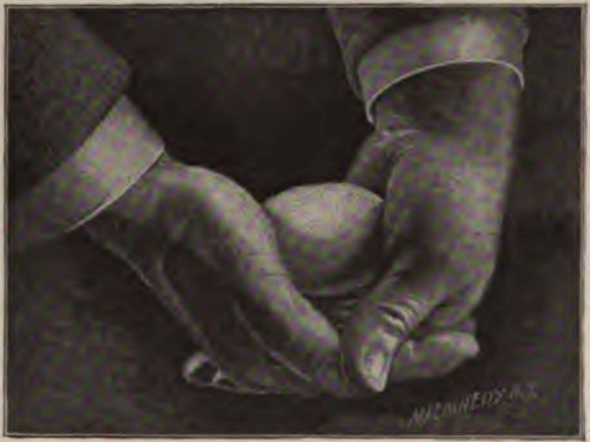

MACHINERY, N.Y.

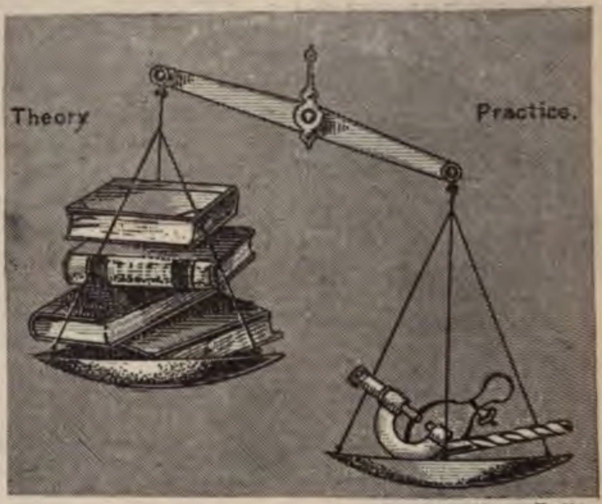
Fig. 7. Testing the Strength of an Egg-shell

Perhaps you say, "these things may be all very interesting, but what can we learn in relation to machine design?" Anybody who knows enough can learn something from somebody else. Can you make a column of steel as strong, weight for weight, as one of oat straw? Can you design a dome which, with the same economy of material, will resist as great a crushing load as a hen's egg? Perhaps you don't know how strong a hen's egg is. I don't mean a bad egg, either. Hold one between the palms of the hands as shown in the cut and, with the fingers locked together, try to crush it by pressing on the two ends of the egg. Then take a handful of chalk and make one. Perhaps, instead of being a designer, you are interested in the economy of management. "Go to the ant, consider her ways and be wise."

The influence of natural forms extends even to the names of shop tools, simply because the form or the purpose reminds us, unconsciously, perhaps, of some familiar form of natural life. A monkey wrench with the slide moving up and down the handle resembles a toy monkey running on a yellow stick, while the grinning jaws of the saurian undoubtedly made him godfather to the alligator wrench. We hear a blacksmith speak of a "snibel," meaning a hook and short piece of rod not unlike a snipe bill in shape and a crane is called a crane because, as the Dutchman said, "dat ish hees name."

### Theory.

It will be said that the foregoing is mere "theory" without any practical bearing on shop practice, and the theoretical person is regarded as one who indulges in useless refinements of any nature as compared to the practical man who accomplishes something. Practice has been defined as "what we know," and theory, "what we do not know." Many sneers have been aimed at school draughtsmen and much amusement has been derived from the idea that "book learning" could be profitably employed in the shop. Much that has been learned in schools and from books or from nature must be unlearned before the student can make successful headway in shop designing; but, owing to his school training, he learns over again so easily that he can well afford to do so and even then compete with the "practical" man who has had only shop experience to guide him. The theoretical man has learned how to do a thing, while the practical man



Machinery, N. Y.

Fig. 8.

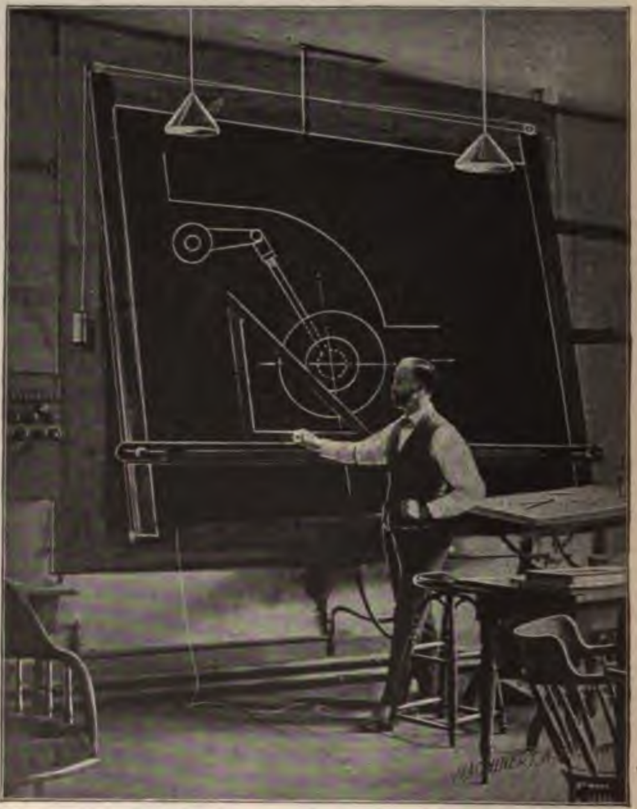

MACHINERY, N.Y.

Fig. 9. Drafting-office Blackboard.

does it, and between the two is a great gulf fixed. To the student it seems as if the chief end of the designer was to make a satisfactory drawing while to the mechanic the drawing is only a means to an end. It is necessary first to get rid of the idea that mechanical drawing is an art. It is a means of expression the same as writing and a competent designer need not be an artistic draughtsman any more than an author or an editor need be a skillful penman. The real skill lies in expressing one's meaning clearly and distinctly and is the skill of the mind rather than of the hand.

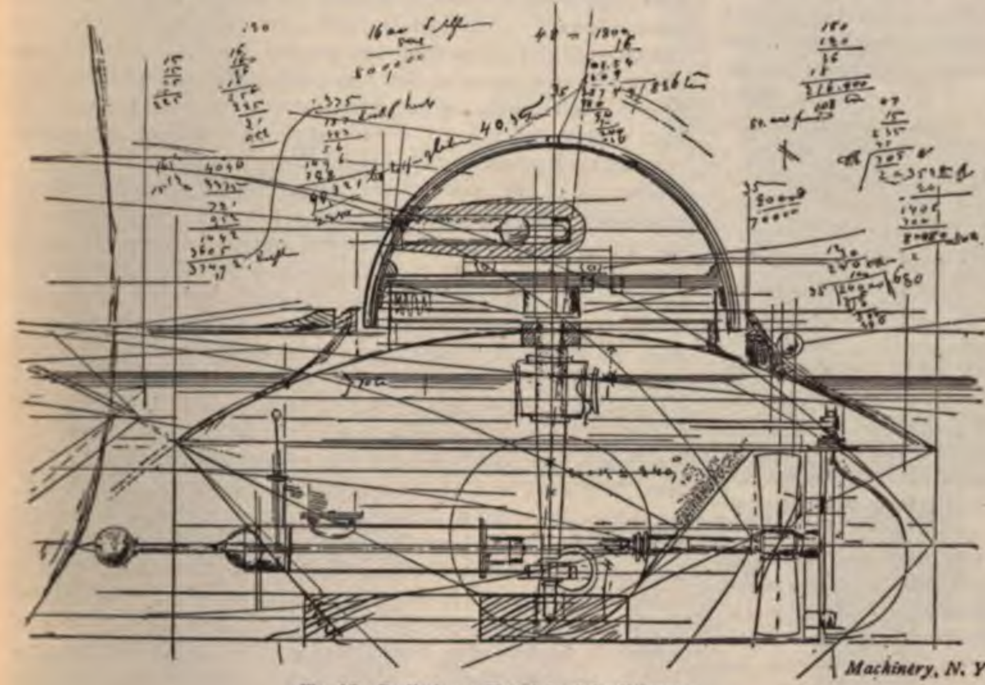


Fig. 10. Preliminary Sketch by John Ericsson.

### Practice.

It is impossible to give a formula for a satisfactory design for a machine, a tool or any industrial appliance. It is the practice in some shops to have a large vertical blackboard so arranged as to be raised and lowered and, on this, to sketch out in crayon a full sized drawing of the machine or of the part in question. See Fig. 9. A council of experts may now "sit" upon it and any suggested changes be easily made in crayon. Other designers go to the opposite extreme and make a series of small sketches, perhaps quarter size, which are easily examined and readily passed around for criticism and from these a full sized drawing may be worked up embodying any suggested changes. There are usually certain unalterable conditions, certain parts which cannot be changed. There are gears and cranks and pulleys which must bear a certain fixed relation to each other and these should be drawn in at once. Mark each such part, its size and its function, "12" driving pulley 4" face, hand lever operating cam," and mark the turning direction of all revolving parts. This will give you a skeleton which you are required to clothe. You are expected to supply head, body and legs all out of your own imagination. As the chap said who made a wooden clock, "made it all out of my own head and have wood enough left to make another."

Fig. 11.

Having well in mind what your machine is expected to accomplish, begin work on your drawing. "Get a move on you." Sketch something. Draw a center line and build your drawing around this. Lay out the greater dimensions, the limiting conditions; let the details wait. Get some lines on the paper and it will cease to stare at you. Block out the general shape somewhat, as shown in Fig. 10. Proportion the various parts about as you think they should be and let the computations go for a little. Ask an experienced designer how he arrives at the various proportions and he will tell you "horse sense," but it is really by bitter experience derived from many errors in the past. It was "horse on him" all right.

By this time you have found out that your drawing isn't what you thought is was going to be; you have run into a "snag." Very well, begin again. Don't try rubbing out unless you see clearly what you are going to gain by it. Paper is cheap and it is no disadvantage to have several sketches on hand, "studies," the artists would call them, and it sometimes happens that the first sketch proves the most available in the end.

### Detail Drawings.

Leave the general drawing about in this stage and make detached detail sketches of the different parts, especially where interferences are looked for, and it is safe to take a good look on purpose for them. Take the machine apart, as it were, and test every member not only for strength, but for appearance as well. Dimension every part and fit them back into the original design. As fast as you are sure of a part, ink it in. Carry along the assembled drawing and the details at the same time, especially at all points where unusual difficulty arises. The usual tendency, especially in cast iron, is toward unnecessary weight. The design looks smaller on paper than it feels in solid iron. Remember also that castings have a trick of coming closer together in the machine than they show on paper.

### Mathematical Refinements.

It will be necessary to make some calculations to determine the sizes both of the working parts and of the frame and supports, and the design may have to be modified to reconcile the changed conditions. Commercially, it does not pay to figure too fine where cast iron is so cheap. The metal must be put in the line of force and given such shape as has been found to offer the greatest resistance to the various stresses; round, like a shaft, for torsion; a T shape for tensile stress and curves for members subject to bending action. Formulae for most of these are usually at hand which one can readily apply even if he does not know how they were obtained. We are obliged to take for granted the accuracy of other tools without knowing how they were made; why should it be necessary to compute a formula before we are allowed to use it? It is not knowledge itself, at this "stage of the game," but the commercial application of it which enables one to make the best and most economical design.

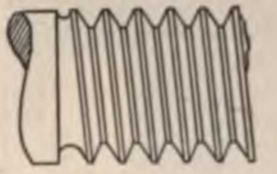


Fig. 12.

Fig. 13.

### "As Easy as an Old Shoe."

We all know how much easier an old shoe is than a new one, not necessarily a worn-out shoe, but one which has been well broken in; and, as in shoes so in machinery. A machine runs better, feels better and does better work after the "new is worn off" and the obvious lesson from this is to so modify our design as to represent our subject when worn to the greatest stage of usefulness, in other words, "broken in." Squeeze a ball of stiff putty in the hand and it will take on the general shape of a handle, as shown in Fig. 11, but showing every mark and crease of the fingers. It fits the hand too exactly for a handle; as the small boy said, "it's too fit." Smooth off all the sharp ridges about as the handle would wear after being in use a considerable time, but without changing the general contour, and we have a well feeling handle. The most popular screw-thread to-day is the U. S. Standard, Fig. 12, which is, after all, only the ordinary V thread worn down. It has been "broken in." The Hindley worm gear, Fig. 13, might be quoted as an illustration of this theory, as both the worm and the gear have the appearance of having been run together until each has worn the other down to a perfect bearing.

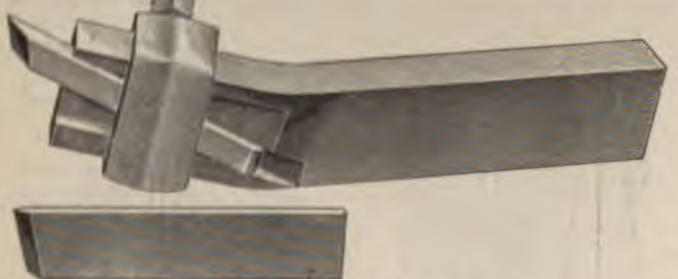
All sharp corners should be rounded about as they would wear off in actual use and this applies not only to castings, but to most machined surfaces, especially such as are to be handled. Nothing offends a critical purchaser more than to pick up a finished tool and feel the burr on the edge. It sets the shivers running down one's back until the "chill is taken off" by rounding the corners.

All ideas are new but once, no one can originate everything. A designer is seldom called upon to make a design for an absolutely new machine. It usually resembles some existing mechanism to some degree, enough to give him some idea of the treatment. It is not always safe, however, to follow even the nearest existing model. The first passenger car was built like a stage coach because of the similarity of purpose; and we are to-day making horseless carriages by simply leaving off the horse, but it can hardly be possible that the best designs for an automobile can be had in this way. That which shows itself well adapted to the purpose is retained and used over and over again until it comes to be the accepted form. It can hardly be said that such designs are copied; they are inherited. As for copying designs in their entirety, it is difficult to distinguish this from any other kind of stealing. Some one has paid for the time and brains and experience necessary to produce an attractive design and the Government recognizes this fact by providing means for protecting the designer by a patent which has a larger scope and a longer life than an invention patent.

* * *

## A COMBINATION TOOL HOLDER.

The tool holder shown in the accompanying cut is somewhat different in its construction from the usual styles. The cutter is not held by the point of a set-screw, but is held to the side of the holder by a clamp having a set-screw on the opposite side from the cutter. The cutter is thus firmly held to the holder without scoring by the point of the screw or without danger of breakage. When the cutter is to be released there is no trouble in doing so, as it cannot become wedged fast by chips, as sometimes occurs where the cutter is held in the usual way. The holder combines a turning and cutting-off tool, as either form of cutter can be used as shown in the cut. The cutting-off blade may be ground at one end for a threading tool. The tool holder is made in four sizes by the Hoggson & Pettis Mfg. Co., New Haven, Conn.



Holder for Turning and Cut-off Tool.

## NOTES FROM A WELL-KNOWN SHOP.

### WITH ILLUSTRATIONS OF GEAR-CUTTING MACHINERY.

The works of Gould & Eberhardt, Newark, N. J., which have been a landmark for many years in that vicinity, have recently lost their familiar appearance. The old walls at the front and sides of the main building have been torn down and new walls with large windows have been built, the style of architecture following closely that used in mill construction. Inside, the changes are not so marked, but another story has been added; advantage was taken of the opportunity to strengthen all the floors; electric lighting has been introduced and to some extent electric driving. The rooms of the building are lower studded than would be the case in a newer building, and the arrangement of the incandescent lamps is well adapted to these conditions, where head room is at a premium. Tin reflectors are used in the shape of an inverted trough, perhaps 30 inches long by 12 inches wide and attached to the ceiling between the floor beams at suitable intervals. These reflectors are lined with strips of looking-glass and contain three incandescent lamps each, which shed the light over a considerable area.

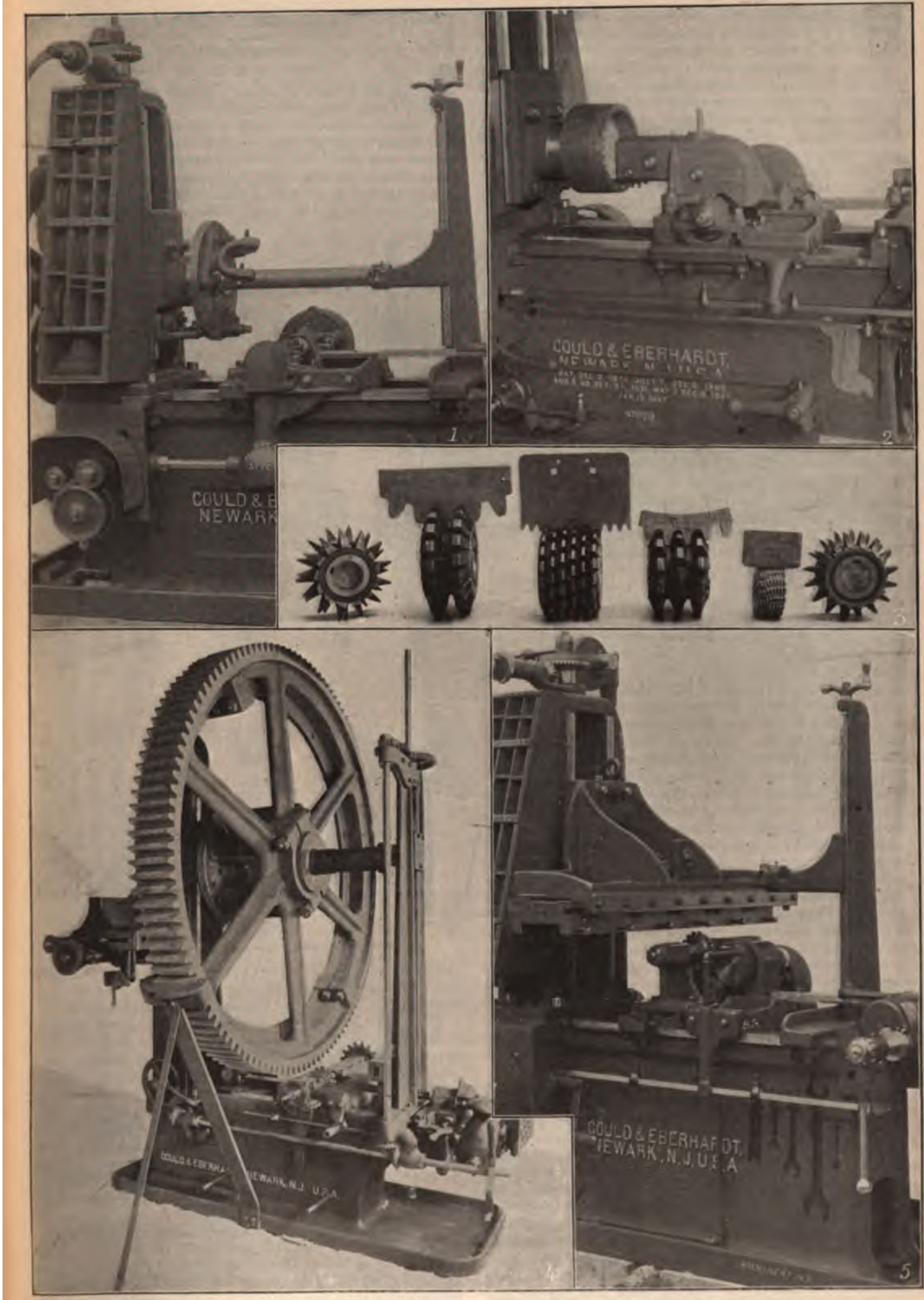
It is interesting to note that this building is the one in which Ezra Gould, the founder of this business, first had quarters for his machine shop fifty years ago. It was here, also, that Mr. Eberhardt learned his trade in the employ of Mr. Gould. The latter had been with the locomotive works at Paterson, N. J., but when he moved to Newark he engaged in the machine tool business, which has been the work of this shop ever since. He was one of the first to build milling machines and gear cutters in this country, and it is probable that, as many of the tools used at Paterson at that time were of English manufacture, he was influenced somewhat by English designs. However that may be, it is a singular fact that his machines differed in some important particulars from those built by most of the older firms. For example, the dividing mechanism of his gear-cutting machines was a worm and worm wheel such as is used on all gear cutters at the present time, while the general practice of the day was to use the index plate for spacing. We have at various times illustrated early gear cutters, which in nearly, if not quite every instance, had the index plate in which holes for spacing were drilled.

Mr. Eberhardt came to this country from Switzerland, and besides learning the machinist's trade had also to learn the English language, which he did at evening school; but in spite of this drawback he was later promoted to the position of foreman and shortly afterwards obtained an interest in the business, which thenceforth went under the firm-name of Gould & Eberhardt. About fifteen years ago Mr. Gould retired, but he is still living, and although very aged occasionally pays a visit to the works. The first machine that Mr. Eberhardt worked upon when starting as an apprentice was a gear cutter, and at the time of the writer's visit this same machine was doing duty as a drill press, drilling holes in the rim of a wheel.

On page 197 are a number of illustrations made from photographs that were selected from a large number that have been taken to show the character of the work and products of this company. About two years ago a new type of gear cutter was brought out, called the "Victoria," which many of our readers will remember we illustrated at that time. In this machine only one belt and pulley are used for driving, and the different movements are operated by spiral gears and splined shafts, which provide for the motion of the various slides. Since that time a number of attachments have been brought out for this type of machine, all of which are entirely automatic in their action. These are shown in the group illustration, together with two other photographs that we think will interest our readers.

In Fig. 1 is the machine with the hobbing attachment, which will hob the teeth of a worm wheel automatically without first nicking the blank. The wheel blank is placed on the work arbor, as is usual, and the hob on the cutter arbor, when the two are made to revolve in unison through the connections with the dividing mechanism which are plainly visible in the illustration, while at the same time the wheel is fed down against the hob.

In Fig. 2 is an attachment at work cutting an internal gear, and the cutter is in this case driven by a train of spur gears, the



MODERN PRACTICE IN GEAR CUTTING.

last gear of the train gearing into a pinion on the cutter arbor. In Fig. 5 is a rack-cutting attachment, consisting of a bracket with a sliding carriage for supporting the rack and a raised bearing for bringing the cutter above all projections of the carriage, so that a rack of any length can be cut. It will be noted that with all these attachments the ordinary carriage that is used for cutting spur gears is made use of.

Fig. 3 is from a photograph taken of several sets of gangs of cutters that are peculiar in that they are so formed that they will cut and finish at one operation two or more teeth of a gear. Thus, the two cutters at the left will finish two teeth at a time, the next six teeth at a time, etc., and when the gear is rotated for a new pass of the cutters, it must in the one case be moved a distance of two teeth, and in the other a distance of six teeth. It is a little puzzling at first to see how this result can be accomplished, since all the cutters are on the same arbor. It is done by so shaping the cutters that the teeth of each individual one will point toward the center of the gear; that is, if a cross-section were taken through the cutters, it would be found that the center lines of the teeth shown in section were radial lines from the center of the gear blank. The outer cutters of each gang are of larger diameter than the inner ones, to conform to the curvature of the gear, and as one set of cutters is theoretically correct for one diameter of gear, their use is limited to the manufacture of gears of the same diameter and pitch that are to be made in large quantities. The cutters at the ends of the photograph show to what an extent it is possible to sharpen correctly formed cutters and still have them retain their shape.

In some respects Fig. 4, is the most interesting one of the group. It is the first one of this new type of machine in which the spiral drives are used, and it is at work upon a wheel of unusual size, showing what is now posible in the line of ordinary practice in gear cutting. The wheel being operated upon is 8 feet 1.6 inches in diameter, 9-inch face, and has a hole through the hub 10 inches in diameter. The blank weighed over three tons before cutting. The teeth are 2½ inch circular pitch, and about 600 pounds of metal were removed in cutting.

An improvement that has recently been added to these machines is an automatic rim clamp that, when once adjusted, will automatically clamp the rim of the blank before the cutter begins its work and automatically release before spacing occurs. The movement of the clamp is governed by an eccentric connected with a shaft that drives the indexing mechanism and thus has an intermittent motion every time the gear is to be spaced.

* * *

In reporting the exhibits at the Philadelphia Commercial Congress, the "Philadelphia Record" mentioned several exhibits of iron articles which showed a beautiful dull black surface that was very attractive for such work. "Sparks" gives this explanation of the process as contained in the "Record:"

It consists in coating the objects very uniformly with a thin layer of linseed oil varnish, and burning it off over a charcoal fire. During the deflagration the draught must be stopped. The varnish will first go up in smoke with a strong formation of soot, and finally burn up entirely. The process is repeated, *i. e.*, after one coating is burned off a new one is applied, until the parts exhibit a uniformly handsome, deep black color. Next, wipe off the covering with a dry rag, and heat again, but only moderately. Finally the articles are taken from the fire and rubbed with a rag well saturated with linseed oil varnish.

# TESTING THE STRENGTH OF MATERIALS—2.

## ROPE TESTS.

EDWARD F. MILLER.

To test the strength of a rope, a tension machine capable of holding a long specimen is required. A simple machine of 30,000 pounds capacity, like that shown by Fig. 1, can be made at a moderate expense. The machine shown can be used for tension work only. The frame and uprights are of 6"x6" hard pine. The pulling screws are of sufficient length to give a motion of 4½ feet to the pulling yoke. The weighing system is quite simple and can be readily followed out in the cut. One end of the specimen of rope is attached to a yoke in the block moved by the screws and the other end is fastened to the loop in the end of the main lever of the weighing system.

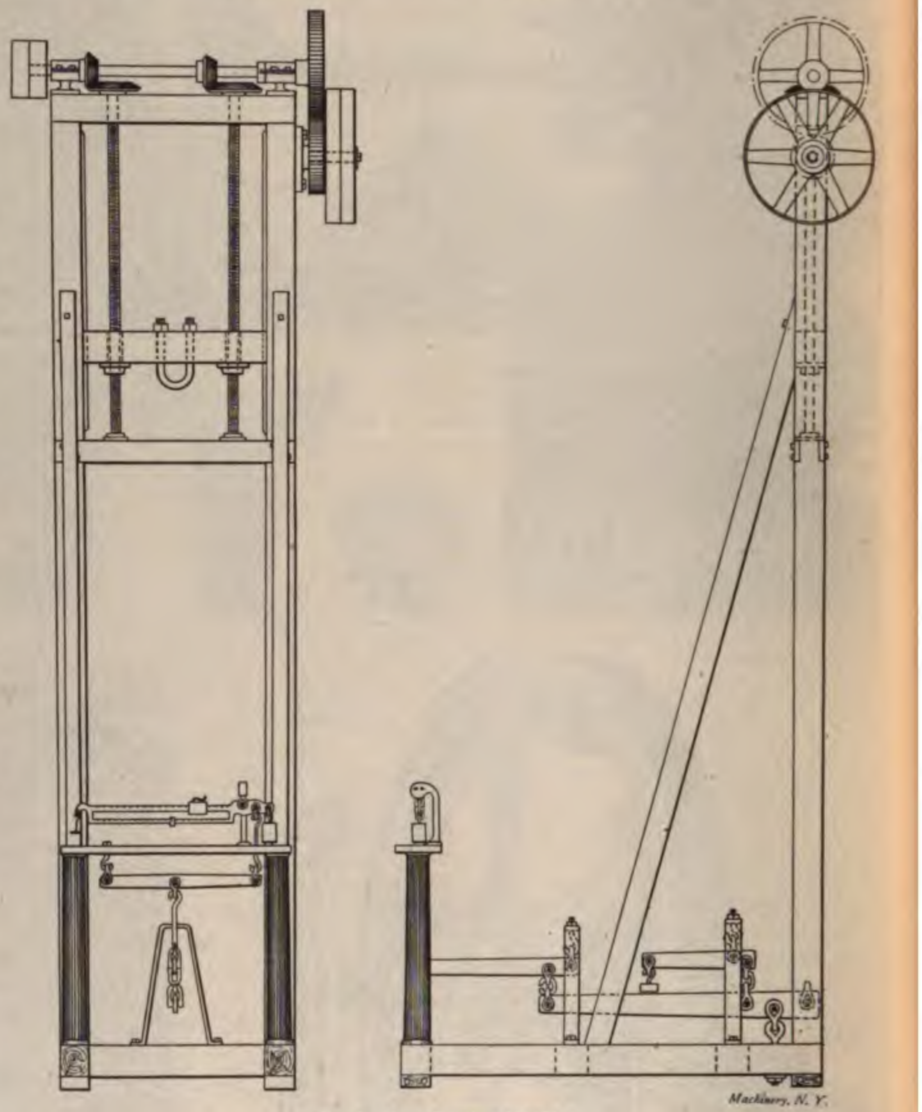


Fig. 1. Rope-Testing Machine.

The greatest difficulty in testing rope is in attaching the ends of the specimen to the machine so as not to have the rope break at the fastenings. The most satisfactory method is to attach by an eye splice at each end of the specimen. Before testing, the splices are soaked in water for 10 or 12 hours in order to harden them. The rest of the rope is not wet. If a knot is tied in a rope, failure is sure to occur at that place. A few tables of tests follow. In some of these the efficiencies of the different knots shown by the cuts have been figured. These tables are interesting, as they show the strength of rope is reduced nearly 50 per cent. by some of the knots commonly used. This loss of strength is due to an injury to the fibers on the pulling part of the rope, caused by a cramping in the knot.

The stretch of new rope under a gradually applied load is given in the following table. These figures are the means of a good many observations. The power end of the testing machine moved at the same rate per minute in all of these tests; hence the time required to obtain a certain load will be greater the reater the stretch. About 10 minutes were required to load he manila or hemp ropes to 4,000 pounds and about 18 or 20 ninutes were required for the cotton rope. The cotton rope is old by the diameter and the hemp and manila by the circum-erence except in the case of transmission rope. The ⅞" otton rope is about 2¾" in circumference. A comparison of the tretch of the ⅞" cotton with the 2½" manila or hemp shows hat the stretch of the cotton is nearly double that of the others. he mani'a and hemp rope were purchased of the Plymouth ordage Co.

TESTS ON THE STRETCH OF ROPE.

| Loads. | Total Stretch per Foot. | | | |
|---|---|---|---|---|
| | 2½" Manila. | 2½" Russian Hemp, tarred. | 2" Manila. | ⅞" Dia. Cotton. |
| | Ft. | Ft. | Ft. | Ft. |
| 500 | .043 | .058 | .031 | .097 |
| 1000 | .070 | .080 | .052 | .136 |
| 1500 | .090 | .095 | .067 | .164 |
| 2000 | .105 | .105 | .080 | .187 |
| 2500 | .119 | .114 | .090 | .205 |
| 3000 | .130 | .121 | .099 | .224 |
| 3500 | .138 | .126 | .107 | .240 |
| 4000 | .146 | .... | .114 | ... |

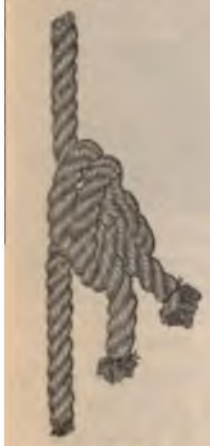


Fig. 2.

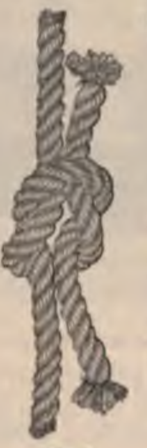


Fig. 3.

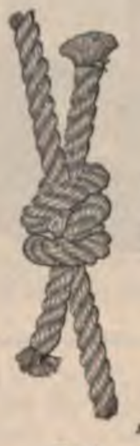
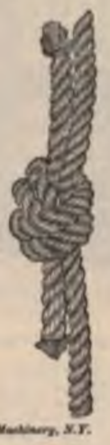


Fig. 4.


Machinery, N.Y.
Fig. 5.

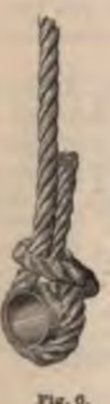


Fig. 6.

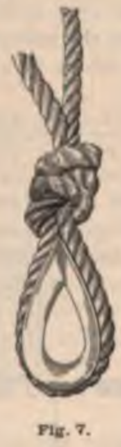
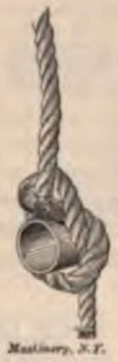


Fig. 7.


Machinery, N.Y.
Fig. 8.

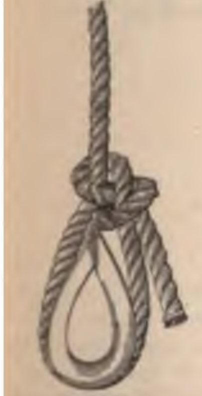


Fig. 9.

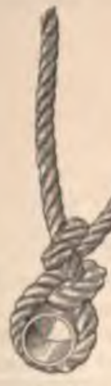
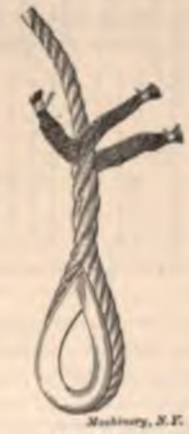


Fig. 10.


Machinery, N.Y.
Fig. 11.

The preceding illustrations show the kinds of knots that were sed in the tests, of which summarized results are given in the ollowing table. The names of the knots are as follows: Fig. 2, open-hand knot; Fig. 3, square knot; Fig. 4, Englishman's tie; Fig. 5, ordinary tie; Fig. 6, plain slip knot; Fig. 7, Flemish loop; Fig. 8, timber hitch; Fig. 9, bowline; Fig. 10, double half hitch; Fig. 11, eye splice.

TENSION TESTS ON ROPE *

| Number of feet per pound. | Number of Turns of One Strand per foot. | Location of Breaks. | Average Strength, lbs. | Efficiency of Knot or Splice. | Method of Holding. |
|---|---|---|---|---|---|
| | | 2½" MANILA ROPE. | | | |
| 5. | 5¼ | At center. | 5,420 | 100 | Spliced eyes over iron eyes. |
| 5.4 | 5⅜ | At knot | 4,280 | 79 | Held at each end by a timber hitch knot over a 2" pipe coupling. |
| 5.6 | 5⅓ | At knot | 3,750 | 69 | Held at each end by a double half hitch knot over a 2" pipe coupling. |
| 5.3 | 5⅓ | At knot | 3,520 | 65 | Held at each end by a slip knot over a 2" pipe coupling. |
| 5.3 | 5¼ | At knot | 2,880 | 53 | Bowline knots over iron eyes. |
| 5.5 | 5⅓ | At knot | 2,500 | 46 | Flemish loops over iron eyes. |
| | | 2" MANILA ROPE (THREE STRANDS). | | | |
| 7.5 | 5⅛ | At center | 4,760 | 100 | Eye splices at ends over iron eyes. |
| 7.4 | 5⅛ | At knot | 3,140 | 66 | Timber hitches at ends over 2" pipe couplings. |
| 7.4 | 6 | At knot | 2,840 | 60 | Bowlines at ends over iron eyes. |
| 7.4 | 6 | At knot | 2,090 | 44 | Flemish loops at ends over iron eyes. |
| 7.2 | 6 | Middle knot | 2,910 | 61 | Joined at middle with Englishman's knot. Held at ends with timber hitches. |
| 7.2 | 6 | Middle knot | 2,700 | 57 | Joined at middle with ordinary tie. Held at ends with timber hitches. |
| 7.3 | 6 | Middle knot | 2,480 | 52 | Joined at middle with square knot. Held at ends with timber hitches. |
| 7.1 | 6 | Middle knot | 2,180 | 46 | Joined at middle with open hand knot. Held at ends with timber hitches. |
| | | 2½" TARRED RUSSIAN HEMP ROPE (THREE STRANDS). | | | |
| 4.4 | 5½ | Near center | 5,250 | 100 | Spliced eyes over iron eyes. |
| 4.3 | 6 | At knot | 3,790 | 72 | Timber hitches over 2" pipe couplings. |
| 4.5 | 6 | At knot | 4,140 | 79 | Slip knots over 2" couplings. |
| 4.1 | 5⅓ | At knot | 2,980 | 57 | Bowline knots over iron eyes. |
| 4.5 | 6 | At knot | 2,810 | 54 | Flemish loops over iron eyes. |
| | | 2½" RUSSIAN HEMP ROPE. | | | |
| 5.5 | 5⅓ | At center | 6,580 | 100 | Spliced eyes over iron eyes. |
| 5.4 | 5⅜ | At knot | 5,100 | 78 | Timber hitches over 2" pipe couplings. |
| 5 | 5 | At knot | 5,090 | 76 | Slip knots over 2" pipe couplings. |
| 5.1 | 5 | At knot | 3,920 | 60 | Bowline knots over iron eyes |
| 5.1 | 5 | At knot | 3,550 | 54 | Flemish loops over iron eyes. |

* * *

## PATENT OFFICE RESOLUTIONS.

At the Washington meeting of the American Society of Mechanical Engineers, held last spring, resolutions were passed urging upon Congress the necessity for legislation leading to the relief of the present overcrowded condition of the Patent Office, and providing sufficient room, force and facilities for the proper execution of its work. The secretary of the society has recently sent a copy of the resolutions to the different members with suggestions for helping the cause and with a statement of some of the difficulties under which the Patent Office is laboring.

The Patent Office, by virtue of its being one of the many bureaus in the Interior Department, has had to contend with a species of rivalry or discrimination, with the result that, by reason of the continued growth and progress of the departmental work, the storage capacity of available areas has been crowded to the utmost. In some cases the weight of papers has reached a point at which further storage upon the floors is forbidden by the building inspectors, with the result that records which are titles to valuable manufacturing properties are crowded into passage ways and elsewhere, where they are not only exposed but where, in case of accidental fire, they could not be saved. Up to the 1st of January, 1899, 693,979 patents had been granted and 41,422 trade-marks, labels, etc., had been registered. Last year 25,527 patents were granted, and 2,260 trade-marks registered. This accumulation has forced the galleries of the halls, originally designed for models, to be crowded with record matter and the exhibition of models has been congested and made practically impossible. With respect to the library of the Patent Office, with its two departments of Science and Law, less than $1,500 was available this year for the purchase of books for the scientific library, and no funds whatever were available for the law library.

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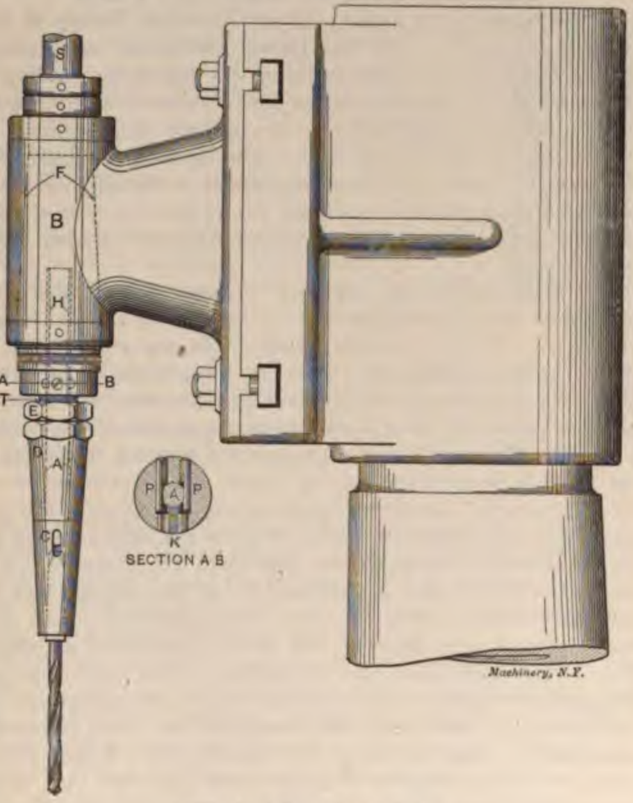
*[This table gives approximately average results taken from a more extended table furnished by the author.—Editor.]

## MULTIPLE SPINDLE DRILL.

A multiple-spindle drill with 34 spindles is shown in the accompanying illustration. In this particular case the machine is intended for drilling the holes in the cutter bars for reapers, but the same design is used for any class of work requiring a large number of holes to be drilled in a row. The rail supporting the bearings for the spindles is carried by five columns and power is transmitted to the spindles through the bevel gears, seen at the top, and the universal joints which allow for adjustment of the spindles to the right or left. Thirty-one of the spindles are for 5/16" drills, two for 13/16" drills and one for a 5/8" drill.

The table, which is supported by knees working on slides in the columns, is operated by three heavy screws which receive motion from the horizontal shafts running lengthwise of the base of the machine. This feed motion is designed to give a slow feed with a quick return by power and a stop motion is provided, so there is no likelihood of accident through feeding too far. When drilling, the table feed-screws are driven by worms and worm-gears, and when it is desired to move the table rapidly in either direction, the screws supporting the table are operated by spiral gears.

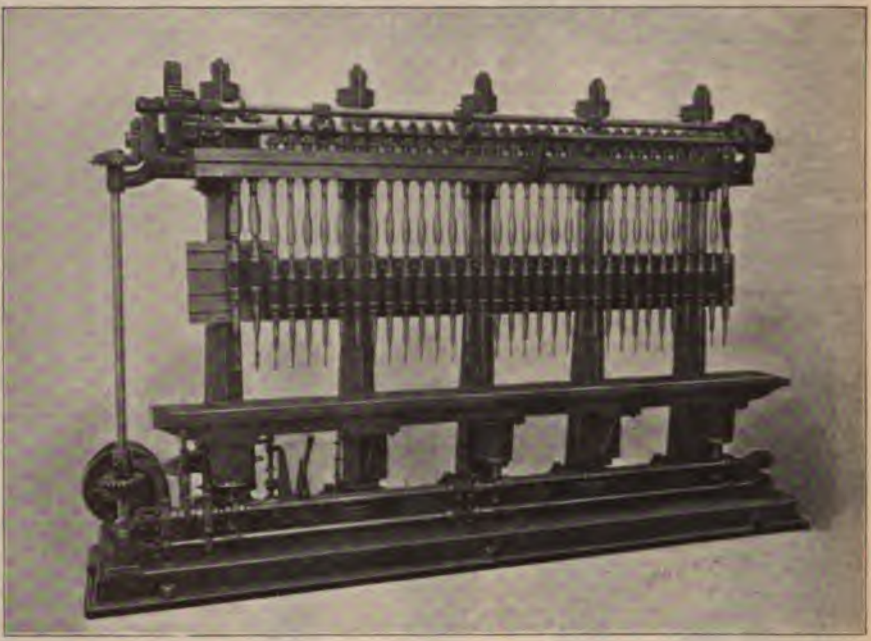
Referring to the lower part of the illustration, it will be observed that there are two feed shafts, and also one driven by a worm and worm gear from the main driving shaft at the left. On the lower shaft are the worms that drive the feed-screws when drilling. At the left end of the upper shaft are a clutch and two spur gears, one of which receives motion from the lower shaft directly and the other receives motion through an intermediate pinion which causes it to revolve in a direction opposite to that of the first wheel. Hence, by throwing the clutch one way or the other, the upper shaft can be driven in either direction and it in turn will drive the feed screws rapidly in either direction through spiral gearing which is plainly visible on this shaft at each of the three feed screws.



Details of Spindle and Head.

There are also clutches on the feed screws, all operated by one lever, which are so connected that it is impossible to throw in both the slow and fast feeds at the same time.

In the line drawing, Fig. 2, are the details of one of the heads of the machine. It is obvious that the drill spindles should be so adjusted that all the drills will commence to enter the work at the same time. Referring to the sketch, S is the spindle and B the bearing with a taper bushing, F, for adjustment. The spindle proper extends below the bearing and is threaded, as shown at T to fit the long nut D and the check-nut E. The collet C, in which the drill fits, has a long shank and extends into the spindle for a considerable distance, as indicated by the dotted lines. This shank is round and fits accurately in the hole in the spindle. Two sides of the upper part of the shank are flattened, as shown in the sectional view, and bear against two flattened pins, P P, which take the torsional strain of the drill.



Drill with Thirty-four Spindles.

If it be desired to lengthen the drill spindle, the set-screw K holding the drill collet in place is loosened and the drill lowered the required distance. The nut D is then screwed down until it bears against the shoulder on the collet and is locked in place, when the drill will have a solid support to take the thrust, and will be driven positively by the flattened pins.

The machine is 12½ feet long, 8½ feet high, and ball thrust bearings are used in the necessary places. The manufacturers are the F. B. Shuster Co., New Haven, Conn.

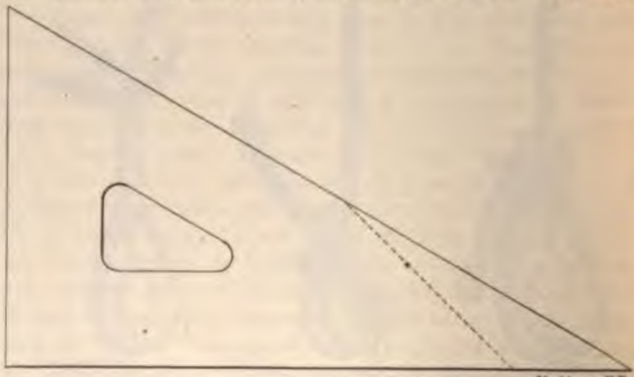
* * *

## OF INTEREST TO DRAFTSMEN.

*Editor* MACHINERY:

If anyone has a 60 degree triangle that is broken off across the 30 degree end, he need not throw it away, but can take it into the pattern shop and, with a mortiser, cut off the broken end at an angle of 45 degrees, as shown by the dotted lines in the accompanying sketch. It is surprising what a useful tool it makes for the drawing-board and I am surprised that such a triangle is not made for the trade.

A. W. DRAESCH.



To Save a Broken Triangle.

## METHODS OF CONTROLLING DIRECT CONNECTED MOTORS.

WM. BAXTER, JR.

The stationary electric motors used at the present time are almost invariably of the constant potential type, that is, they are so made as to be operated by the current furnished by incandescent lighting companies. Alternating current motors are coming into use slowly but are not likely to become common for some time to come, hence, this article will be confined to the first named type.

Constant potential motors are made with three different styles of field winding. The simplest is known as the series motor, the next in order as the shunt motor, and the last as the differential, or compound wound motor. The series winding is used for cases where it is not desired to run at a constant speed, and also where the power required is constant, in which case the motor speed will be constant. As examples of the latter kind of service we may mention the operation of blowers and pumps that raise water against a given head or uniform pressure. As examples of variable speed cases we may mention hoisting machines, printing presses, lathes, etc. Variable speed work can also be performed by motors of the shunt or compound type, and these are used for such cases, and as a rule they are more desirable, from the fact that, if provided with a suitable regulating switch, they can be made to run at a constant velocity when required, regardless of changes in the load thrown upon them. This result cannot be accomplished with the series machine. In all cases where a constant speed is required all the time, the shunt and compound motors are the only ones that can be used.

Every type of constant potential motor, with the exception of the commutated field series machine, requires a starting rheostat, and if the speed is to be varied after the machine is in motion, then in addition, a regulating switch is necessary. This regulating switch is commonly called a controller. The starting rheostat is simply a resistance that is placed in the circuit of the motor armature in the act of starting, so as to keep the current strength down to reasonable limits; and in the case of the shunt motor, also, so as to enable the machine to start with a load. The starting rheostat is generally so constructed that after the motor has been set in motion, the switch is held in position by the attraction of a magnet, or by a catch; but at any time thereafter if the current strength rises to a point that would endanger the machine, the switch is released and immediately flies back to the stop position and thus cuts the current off. Starting rheostats of this kind are used with all types of motors, that is, with the series, the shunt and the compound, where manual speed regulation is not required when the machine is in service. When it is desired to regulate the velocity, manually, the starting rheostat is generally discarded, and a controller is provided that performs the office of motor-starting rheostat, as well as that of speed controller.

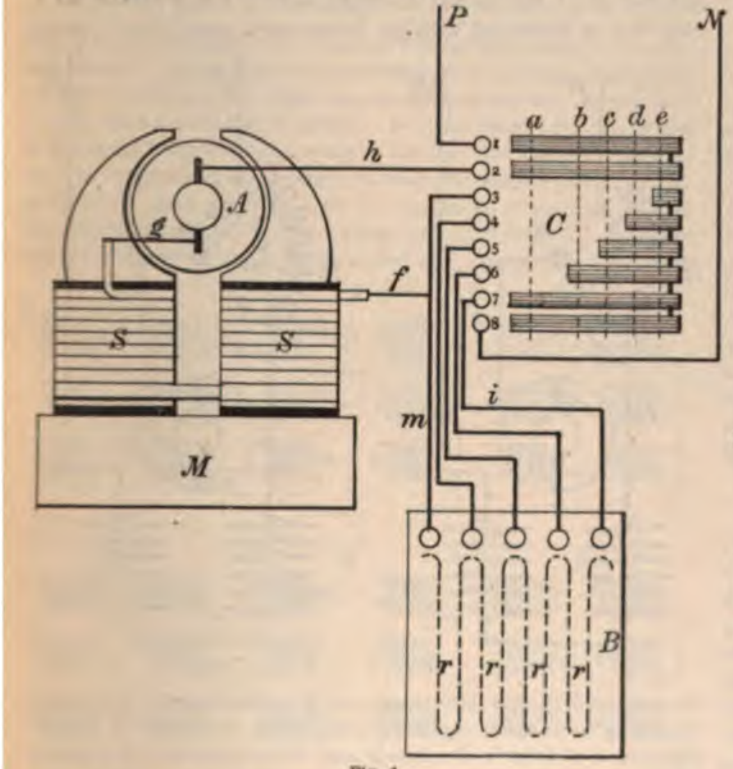


Fig. 1.

The diagram Fig. 1 illustrates a controller used with series wound motors, which is known as the rheostat type. The manner in which this switch is connected in the circuit is illustrated in Fig. 2. When the motor is started, the switch is in the position shown in the latter figure, and thus cuts into the circuit all the resistance of the rheostat. As the speed of the motor increases, the switch is moved downward, and when full speed is attained it rests in the lowest position, that is, on contact a. This is also the way in which an ordinary motor starting rheostat acts, and that is the reason why this type of controller is called rheostatic. The difference between a motor starter, and a rheostat controller is that the first is made so as to be locked in its final position and to be released by the current, while the latter is not locked in any position and can be set anywhere at the will of the operator. Another difference is that the starter is made of much smaller current carrying capacity. In a motor starter the resistance is traversed by the current for only a few seconds, in the act of starting, therefore the heat generator in it is small and can be dissipated by an apparatus of small dimensions; but a motor controller must be of such size that it may be traversed by the current all the time without being overheated.

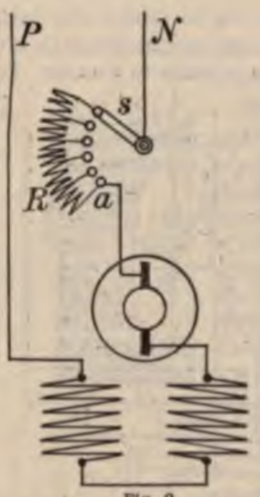


Fig. 2.

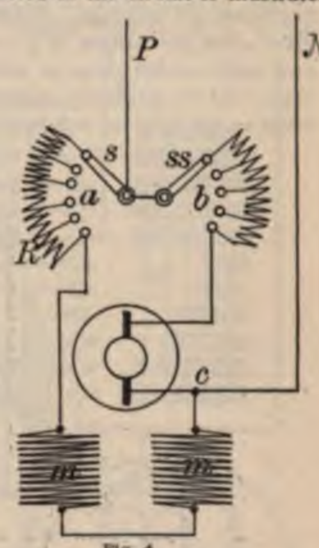


Fig. 4.

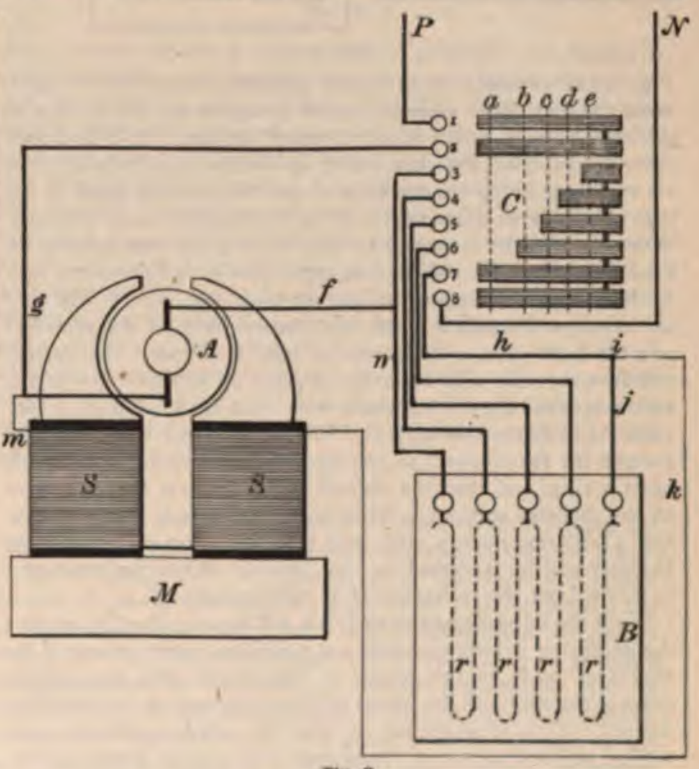


Fig. 3.

A motor starter has to be moved only when the machine is started and stopped, therefore, the switch part can be made in the form indicated in Fig. 2; but a controlling switch has to be moved frequently, sometimes every few seconds, hence, the switch part must be strong and capable of withstanding any amount of rough usage. In the design of controller most commonly used, there is a vertical row of contacts to which the terminals of the motor armature, the field coils, the resistance sections and the line wires are attached. These contacts are so placed that they press upon the surface of a cylinder which has its surface covered with contact rings of such length and so joined with each other, that the necessary connections of the various terminals are made as the cylinder is turned from one position to another. In Fig. 1, the vertical row of circles numbered from 1 to 8 represents the stationary contacts, while C represents the surface of the cylinder as it would appear if rolled out flat. At B is shown the resistance, or rheostat, which is divided into four sections r r r r, these being connected with the five binding posts at the top. From these posts wires run to the vertical contacts 3 to 7. When the cylinder is turned so that the contacts rest upon it, on the line a, contact 1 will be connected with 2, and contact 7 with 8. With this connection the current from line wire P will pass to the top commutator brush and thence through the armature and the field coils, coming out by wire f. From f the current will flow through wire m to the rheostat B, and after traversing all the sections r r r r will reach wire i and thence, through contacts 7 and 8, the line wire N. When the cylinder is turned far enough for the contacts to rest upon line b, contact 6 will press upon a ring, and then the current will only pass through three of the rheostat sections. When the position c is reached, contact 5 will rest upon a ring, and then only two sections of the rheostat will be traversed by the current. When the position e is reached, all the resistance of B will be cut out.

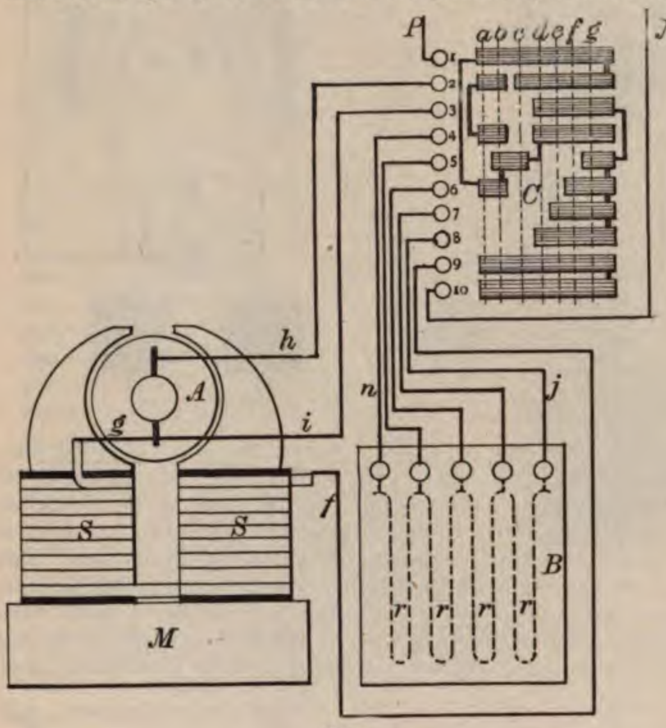


Fig. 5.

From the foregoing explanation it will be seen that, by placing the controller cylinder in different positions, more or less of the resistance of B can be placed in the circuit, and, as a consequence, the speed of the motor can be increased or decreased, as desired. This arrangement is what is called a rheostat controller, and it is shown in connection with a series wound motor. A series wound motor is one in which all the current passes through the field coils as well as through the armature. Fig. 3 shows a rheostat controller connected with a shunt wound motor. A shunt wound motor is one in which a very small portion of the current passes through the field coils, and the balance passes through the armature. A simple rheostat controller when used in connection with a shunt motor, has to be supplemented by a motor starter, and the two devices are connected as illustrated in Fig. 4. In this diagram, a is the controller and b the motor starter. The latter is placed in the armature circuit, so that the current passing to the latter must also pass through the resistance of the starter. To start the motor the switches s and ss are closed, and then ss is moved down slowly so as to reach the lowest contact by the time the machine has gotten up to full speed. After that, the velocity is regulated by the movement of switch S, that is, by the movement of the controller cylinder handle. The movement of the controller in this case acts to cut in or out of the field circuit, more or less of the resistance B in Fig. 3. In this way the strength of the current passing through the field coils is varied, and thus the speed of the armature is regulated.

Series motors are sometimes regulated by providing a by-pass or shunt circuit around the armature, so that all, or any portion of the total current may pass through the armature. Fig. 5 shows the appearance of the controller cylinder surface when arranged for this type of control, and Figs. 6 and 7 indicate the connections in the act of starting, and after the motor is under headway. In Fig. 7 it will be seen that the current coming in through line wire p can pass through switch s to e and thence to and through the armature, coming out by way of the lower brush b. It can also pass through the resistance R and through wire d, thus reaching point c without passing through the armature. Now it is evident that if the resistance of R is reduced, the current through it will be increased and that through the armature will be reduced. If we were to attempt to start the motor with this connection, the current passing through the armature would be very great. Therefore, to avoid such an occurrence, the starting connection must be as in Fig. 6 in which, it will be noticed, wire d is disconnected from R, and the latter is in the circuit of the armature, so that all the current coming through wire P must first pass through R and then through the armature. In Fig. 5, when the contacts rest upon line a, the current passes from contact 1 to 6 through the connection shown. From contact 6 the current passes to center post of B and through the two sections r r to the left, and thus to wire n, and contact 4. This contact, as will be seen, is connected with 2. Thus the current after passing through one-half of the resistance of B finds its way to the top commutator brush, through wire h. Leaving the field coils by wire f, the current reaches contact 9 which presses on a ring that is connected with the lowest one, upon which contact 10 rests, and to this latter line wire N is connected. When the controller cylinder is moved to position b, only one of the resistances r of B is in the circuit, and when position c is reached all the resistance is cut out. When position d is reached, contact 4 is connected with 1 and then the wire i will be connected with contact 3 and, through the cylinder connections, with contact 8, which, by means of wire j, connects with the right side of B. Thus in this position the circuit connections become as in Fig. 7, and the further advance of the controller cylinder acts to reduce the resistance in the shunt circuit around the armature, and thereby reduce the current through the latter and consequently the force with which it turns.

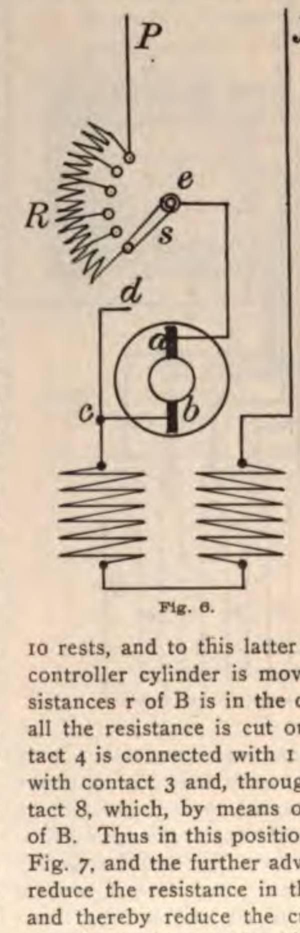


Fig. 6.

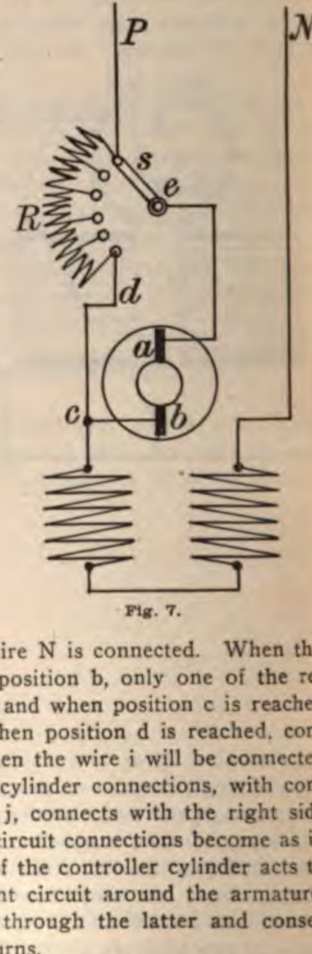


Fig. 7.

Fig. 8 illustrates a series commutated field controller. As will be noticed, the field coils are divided into three sections which may be of the same size or not. If they are made of unequal sizes, a greater range of regulation can be effected, but for the sake of simplicity, we here take them of the same size. Fig. 9 shows the way in which these field coils are connected for the different positions of the controller. In position A all the sections are in series, so that the full strength of the current passes through all the coils. Under these conditions the speed of the motor will be the lowest, and in the act of starting the current that can pass through, the armature will be kept down to reasonable limits. In position B the current passes in series through the s s and t t coils and the other two are entirely cut out. In position C only the s s coils are in service. In these three steps the speed is increased progressively owing to the fact that the field magnets are not magnetized so strongly in each succeeding position. In position D, the s s and t t coils are connected in parallel, so that the current is divided between them, and in position E the three sets of coils are connected in parallel and through each set only one-third of the current passes. A fifth combination is shown at F, but the controller in Fig. 8 is not provided with means for effecting this combination. With this arrangement the armature and field are in series, so that all the current passes through both parts; hence, this type of connections is called the commutated field for series motor. Commutated field controllers for shunt motors are also made, but like the rheostat controller for shunt motors, they have to be supplemented by a motor starter, or a controller so arranged as to perform the office of starter as well as controller. The types of controllers shown in Figs. 1, 3 and 8 are the best, and Fig. 5 is not often used .

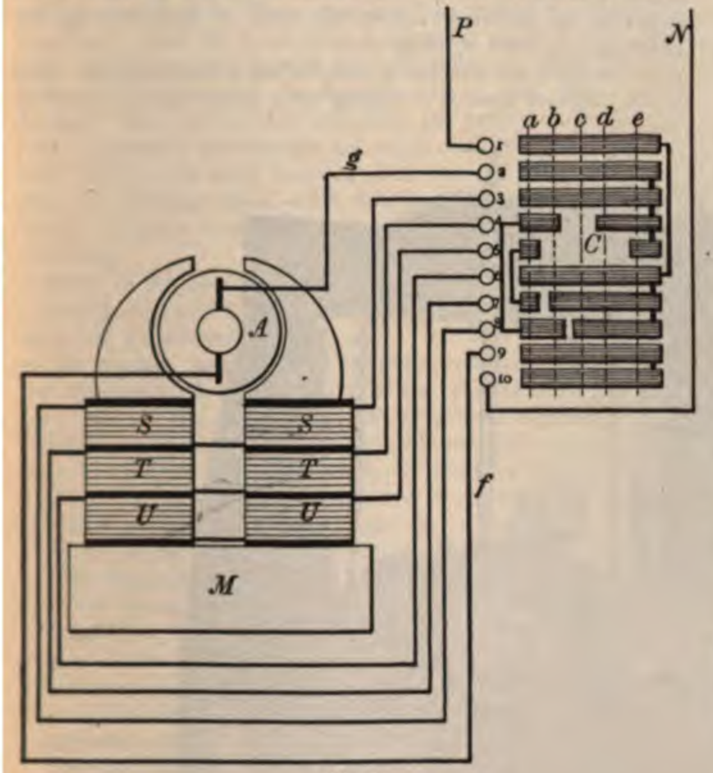


Fig. 8.

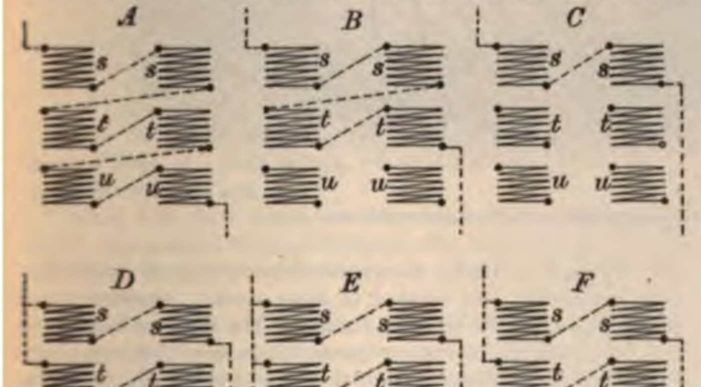


Fig. 9.

All the arrangements shown in the illustrations so far mentioned, can be used in connection with reversing motors as well as with those that are required to run in one direction only. To make any one of these controllers of the reversing type, all we have to do is to add two contacts at the top, as shown in Fig. 10, which illustrates a reversing controller of same type as Fig. 1, and increase the diameter of the cylinder slightly, so as to be able to locate thereon a duplicate set of contacts, as indicated at C C. Looking at the contact rings on both sides, it will be seen that the difference between them is, that in those on the right, rings 1 and 3 are connected as are also 2 and 4, while in the left hand side, ring 1 is connected with 2 and ring 3 with 4. It will also be noticed that contacts 2 and 3 are connected, by wires h and k, with the commutator brushes and that contact 1 connects with the end of the field coils and contact 4 with line wire p. Now to reverse the direction of rotation of a motor all that is necessary is to reverse the direction of the current through the armature, leaving that through the field unchanged, and this is accomplished by reversing the connections. As will be seen when the contacts rest on line a to the right, the top commutator brush is connected with line wire P, and when the contacts rest in the same position to the left, the top brush is connected with the end of the field coil.

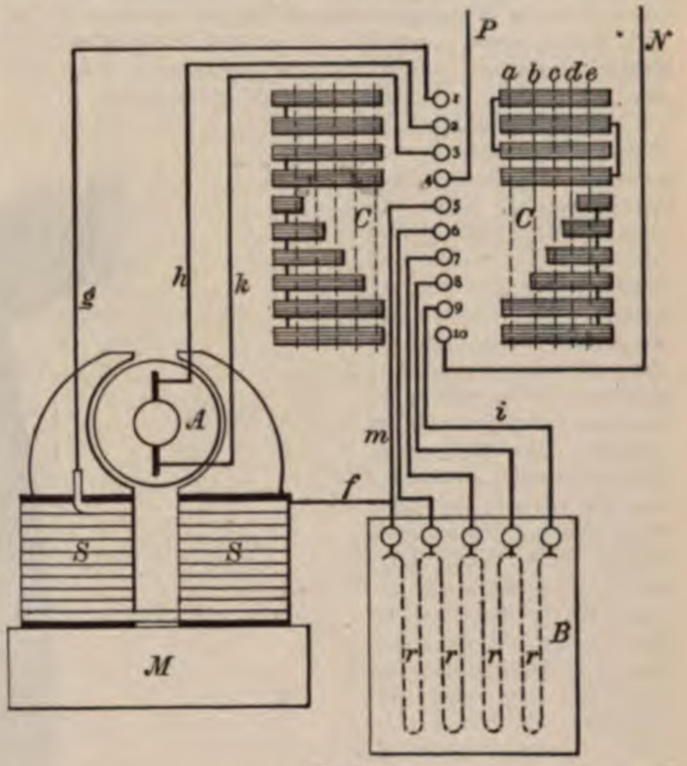


Fig. 10.

* * *

There is one feature in connection with electric driving for machine shops which may be of more importance than the much-discussed question as to whether it is the most economical method of power distribution. When line shafting is used the arrangement of the shops, tools and shafting must be guided largely by the location of the power. It is a case of adapting the arrangement to the power so that the transmission may be both low in first cost and economical to operate. With electric driving, on the other hand, the power can be adapted to the work and the arrangement of the shops, and tools can be such as will afford the greatest facilities for rapid production without regard to the question of the convenient transmission of the power.

* * *

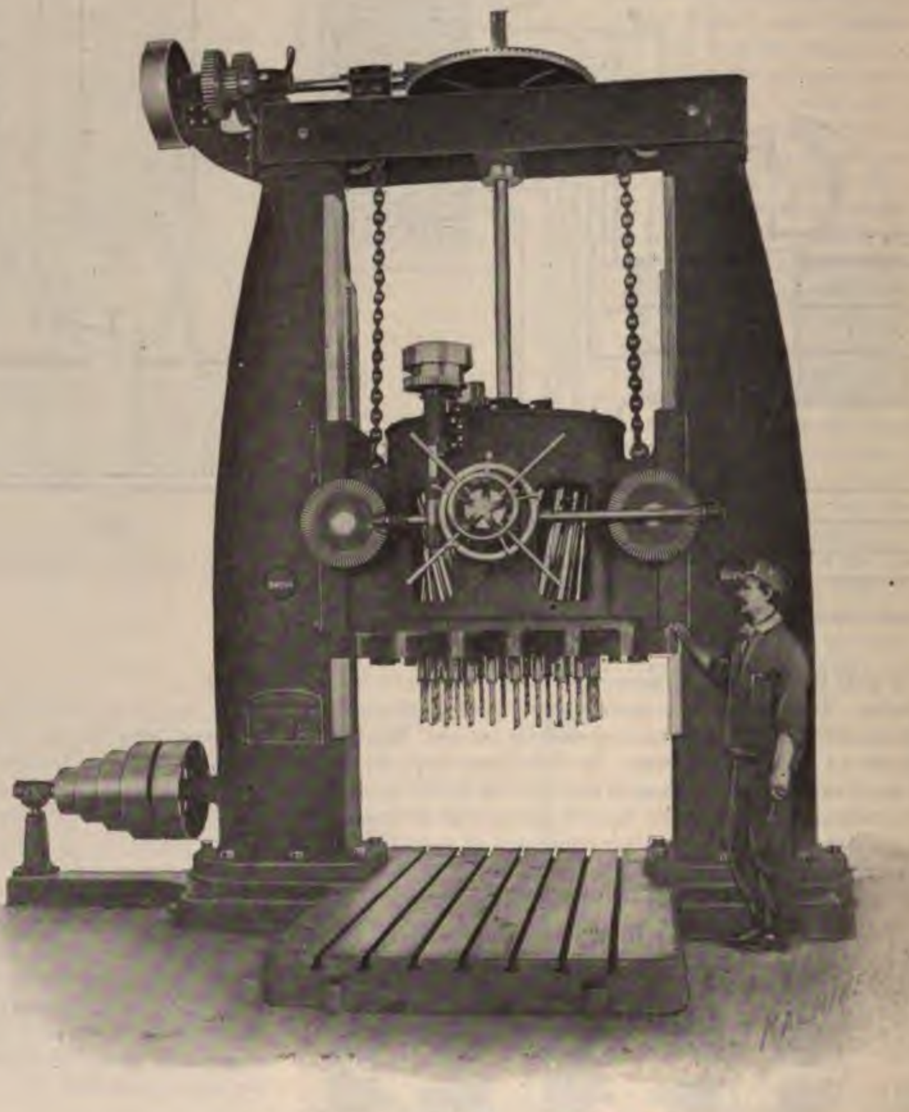
Nations have arisen, cities have been founded and fallen into decay, great battles have been fought, literature and the arts flourished while the steam engine was unknown and the telegraph undreamed of. Surrounded to-day with every luxury, many live contented lives who have never sent a telegram or seen an electric car. Coleman Sellers.

## LARGE MULTIPLE-SPINDLE DRILL.

A multiple-spindle drill of unusual proportions has recently been built by the Baush & Harris Machine Tool Co., Springfield, Mass., and is now added to their regular line of manufacture. It is designed especially for drilling the flanges, etc., of large valves, steam and water cylinders and any similar work where a large number of holes can be advantageously drilled at the same time. The machine has 24 drill spindles and has sufficient power to drill 24 1¼-inch holes in cast iron at once. The extreme height of the machine, with the head raised, is 16 feet and the floor space occupied is 14 feet by 6 feet 6 inches. The general proportions can be judged by comparing with the operator, who appears in the illustration with the machine.

The drill spindles, with the driving mechanism, are contained in a massive head which bears upon two uprights or posts and is guided by them. The power and hand feeds and quick-return motion, usually found in single-spindle drills built by the company, are applied to this machine, the only difference being that the feeds are applied to the head instead of to the spindles, so that the latter all feed simultaneously, as is usual in multiple-spindle drills. Each of the posts has a steel rack into which the feed pinions of the head mesh so that the downward pressure when feeding is constant and evenly distributed. While the head is heavy, it is so carefully balanced that it is easily raised or lowered by hand.

The spindles are driven through universal couplings and can be moved radially or circumferentially so as to drill to any circle or to any desired spacing within the limits of 37 inches diameter for the largest circle and 18 inches for the smallest, with 24 drills. Holes can be drilled at center distances as small as 2¾ inches. The general arrangement is the same as that used in the single post machines built by the same company, and which have already been described in these columns.



Multiple-spindle Drill with Twenty-four Spindles.

The general specifications are: extreme distance, spindle to bed, 5 feet 6 inches; least distance, 18 inches; distance between face of posts, 5 feet 1 inch; speeds, 46 to 325 revolutions; feeds, 1/16 to 1½ inches per minute; changes of speeds, 8; feeds, 16.

* * *

Judging from letters that we have received from several firms in Great Britain, the general opinion is that the South African war will not injure the machinery trade in that country, and some state that it is a positive benefit to the industry as a whole and will probably continue to exert an influence in that direction. While there is a falling off in the demand for mining machinery, such as has been shipped to South Africa in considerable quantities, this is more than offset by the demand for war material. The call for machine tools to turn out these products, as well as for regular lines of work, is active. There is a great scarcity of raw material and coal is getting scarce owing to the limited capacity of the collieries. Of the number of men who go to the war, few are of the class who hold positions as mechanics in manufacturing establishments. The number of engineers who are in the government service is very small.

## AT THE BILLINGS & SPENCER SHOPS.

A representative of MACHINERY who called at the Billings & Spencer Co.'s, Hartford, Conn., recently found all departments busy and engaged upon a great variety of work, both in the machine and drop forging line. The drop forging department has 60 drop-hammers ranging from the mammoth 3,000-pound hammer previously described in these columns, to the smallest sizes. A significant fact is that a great many motor carriage forgings are now being made, and the variety of other work called for by customers shows the value of drop forgings for practically all lines of metal work.

In the office are samples of many of the pieces that have been made. One of these is a forging for a pistol butt produced by Mr. Billings in 1862. A considerable number of machinists' tools are forged and finished at these works, ranging from a small pin vise to the largest wrenches. The latest of these tools is a neat knurling tool which possesses features that mechanics will appreciate. The shank of the tool is to be placed in the lathe tool post and on its outer end is a swivel holder with two sliding jaws, similar to the jaws of a vise, which can be closed or separated, by a thumb screw. These jaws slide in a vertical plane and each one carries a knurl. It is thus possible to so adjust the holder that one knurl will come below the piece to be knurled and the other diametrically above it. When the knurls are then brought together, the pressure of the upper one upon the work balances the pressure of the lower one and no strain is brought upon the lathe centers. This tool is said to knurl rapidly and to do good work.

In view of the many uses to which drop forgings are put, some of which require the best tool steel, this company have their own chemical laboratory and have adopted the plan of analyzing samples of all steel used so that it will be known to a certainty what the percentage of carbon is in each case.

nong the interesting work done here are the hollow crowns icycle forks that have been so much in vogue the past three ur years. These crowns are in the shape of an inverted U are hollow all the way through. A section through one e arms of the U would be oval in shape, with a uniform ness of the metal all the way around. When these were nally made in the form of castings, they were clumsy and y, but now that they are forged they make a light, strong a pretty piece of work. The process is first to forge the l into a Y-shaped piece with cylindrical arms at right s to each other. These arms are then drilled from the ends, hwise, until the holes meet at the point where the two arms They are then heated and put under the drop hammer, it is found that, by suitably shaped dies, they can be ght into the U-shape and have the oval cross-section as At first it was thought necessary to fill the holes that had drilled with sand, resin or some other material, just as is in bending pipes, when finishing the piece; but it was l that if the conditions were right this precaution was unsary.

any of the dies used in drop forging are so large that most makers would hesitate before trying to harden them, if they not accustomed to such work. No secrets are employed e process, however, and excellent results are obtained by old-fashioned methods of a proper application of fire and water. The dies are heated in furnaces resembling caseening furnaces and then withdrawn and their faces held in a of running water, the supply bubbling up beneath the die to continually change the water in contact with it. Water o poured over the back of the die in sufficient quantity to the surface of the block straight and true, as determined e frequent application of the straight edge. At the right the dies are removed from the water and left until the temas been drawn to the desired color, the temperature at the r of the block generally being high enough to effect this. lening these dies requires much skill and experience, but nethod itself has no features that most mechanics are not ainted with.

e machine department of the Billings & Spencer Co., while ably secondary to the drop forging department, is an imnt adjunct to the business. Besides the die making, which requires a large force, many of the forgings are finished plete, machine work and all, before shipping. Drop hamare also made in a variety of sizes. These have recently improved in a number of particulars, not the least of which e substitution of heavier frames for the ones that were for- y used.

* * *

## NOTES FROM NOTOWN.

### TED, A BUSINESS MANAGER—FINDING FAULT VS. SUGGESTING A REMEDY.

I. Podunk.

vent to see an old friend of mine the other day and found in kind of a peculiar fix, yet so far as his end of the job , it wasn't so bad.

'hat this place needs," said Jackson, "is a business man- It's a good shop—new tools, nice class of work and fine le to work for, but it makes me ache to see things going ey are.

ou know we are building a new style sausage stuffer that do the job up neater than any machine I ever saw; chops eat (I almost said dog, but that would be giving away trade ts), stuffs the cases in just even shapes and is a daisy rally. There's a great demand for them right here in Chi- and we ought to be turning out a dozen a week—but we're

he inventor tries to run the business part of the concern it don't go. I used to think that if the shop end was all , almost any old thing in the office could keep track of or- and things, but I found I was mistaken. They are both ate trades and I wish I knew 'em both, too.

'ell, to begin with, their inventor wants to invent every- he uses from speed lathes to jib and traveling cranes; conently we were a year getting in shape. Rigged up his grinding lathe, or grinder, he calls it—at a time when we ought to have been turning out machines instead of monkeying with home-made rigs like that.

"Worst of it is, the business management of the place is done by the inventor, too, and he's too busy inventing to pay much attention to the other, and the other counts too, I find. Orders don't even get to me straight until I chase 'em up, and if I was one of the balky kind of men things wouldn't go at all."

Jackson was called away here and I did a little investigating myself, only to find Jackson was right. There was every appearance of thrift about the place, time clock—of the wrong kind however—and other fixings, but things simply dragged along because there wasn't any one to do the steering of the machine. I used to kick at the thought of a manager drawing a big salary and apparently doing nothing, but if it wasn't for this same manager the business would go to smash and you and I would be hunting for a job, perhaps. You don't think he earns so much more than you do? He couldn't run your lathe on your work to save his neck? Probably not my friend, but the reason he gets more than you and I do is because there are lots of men who can turn out just as much and as good work as we can (though they've got to be hustlers, I'll allow), but there's mighty few who can fill his place. If you can find a job that you can do better than anyone else, your wages go up. It's just so with a manager, and if you want to see your name on the pay roll up at the head of the list, just try to learn how things ought to be managed. Don't know how to begin, eh? Well, perhaps I can't help you very much, as I'm no spring chicken, and I still wear overalls, but if I wasn't too old to think of such a thing, I'd try something. When the boss orders a change in any work, try and reason out the "whys" of the case and look at the other side as well as your own. Decide for yourself, but don't tell anyone else whether you think it a good move or not and then watch results. Don't wait till afterward and then imagine you decided right, for a manager has to decide beforehand. Just imagine you are running the shop or even one department and plan out how you could save money for the firm by reducing the cost of production without reducing wages. Think out some system of keeping track of work so you can know what it costs. Find out who turns out the most work, which machine pays the best, and a dozen other points a manager ought to know. When you can do this you are getting to the point where you can appreciate what is required of a manager, and perhaps find an opening of this kind yourself. It's worth trying at any rate.

This leads me to remark that, very often, we are apt to find fault with things and people without being able to suggest a remedy. We criticize the design of a new machine in the shop, yet can any of us, or do any of us suggest a better one? Criticism is a good thing, but it is well to have a substitute to offer for the article we condemn.

"Unhandiest lathe I ever saw," says one, but how would you improve it? Of course you can do it—probably—but isn't it better to do it than to growl about it? Begin at the carriage, the part you notice the most, and, while your lathe is in a cut study out how to make things better. Then, when you get time, make a few sketches to show your ideas.

Sketches are good things in several ways. They train a man's fingers, as well as his brain, and they show up the fallacy of an idea, pretty correctly too, if they are well made.

If any mechanic follows this plan whenever he can, he is sure to add to his stock of ideas and to be able to express them on paper. It also makes his opinion of more value, and when he kicks at something he doesn't like, he isn't a mere growler but is recognized as one who has improvements to suggest. In other words, it is the difference between those who tear things apart with no idea of how to improve them or build them up, and those who do not attack existing conditions until they have something to offer in their place. The last man is the chap who will succeed in life.

* * *

At Holyoke, Mass., the "Paper City," a new dam has recently been completed across the Connecticut that is 1,020 feet long, 30 feet high and is the second largest overflow dam in the world, the largest being at Austin, Texas. The new dam is located about 100 feet below the old dam, which made Holyoke famous as the city with the largest developed natural power in the world. Nearly 11,000 pieces of granite were used in the new structure, and 39,000 barrels of cement.

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## MARCH, 1900.

## CIRCULATION STATEMENT.

The regular edition of MACHINERY for March is 25,000 copies. AMERICAN MACHINERY is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. Except on the special quarterly numbers, no papers are sent free other than to advertisers, exchanges and circulation agents.

The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

| | |
|---|---|
| THE IRON AGE, about | 7,000 |
| THE AMERICAN MACHINIST, about | 12,000 |
| MACHINERY | 25,000 |

It so happens that we are able to illustrate this month two multiple-spindle drills, which show in a very striking manner the tendency of modern shop practice when the volume of business is sufficient to warrant their use. One does not have to go back many years to reach the time when multiple-spindle drills or any other type of machine for performing more than one operation at once were scarcely known. Later small machine parts began to be made by such methods, and now, with better facilities for handling large machines, a great deal of the heaviest class of work is done on this principle. One of the machines that we refer to is for small work and is unusual from the large number of spindles that it contains. The other is for a heavy class of work and is more massive than any similar machine that we remember to have seen. The two together illustrate how completely both heavy and light work has come under the sway of what may be termed the modern method of machine manufacture.

* * *

## AN OBJECT LESSON.

The employees of a certain New England shop, which is doing a good-sized business, were surprised on pay day, a short time ago, to find that their envelopes contained m[illegible]oney than was due them for the number [illegible] during the week preceding. Individual employees called at the office to say that there had been a mistake, while others, who compared notes, found that all had been treated alike and that the surplus received by each was 10 per cent. of the previous wages.

While this is a pleasing (and somewhat unusual) instance, there are several things that may be said in connection with it that are even more unusual than a uniform increase of 10 per cent. in wages. In the first place, the raise was unheralded and as far as we know no attempt was made to advertise the fact, no mention being made of it, even in the local papers. It is an old-fashioned shop with many tools and methods that are not strictly what we would call modern. The shop has paid large enough dividends, however, in spite of these drawbacks, so that the directors were willing to accord a slice of the profits to the men by whose labor the money had in part been earned.

Among the old-fashioned features of this shop, or rather the lack of modern features, is the absence of a checking system for the employees, when they commence and close their day's work. If a man is a few minutes late in the morning no account is taken of it, but if he is habitually late, his services are no longer wanted. The shop is rather dark and not as clean looking as many of the newer structures, and it does not have the shower baths, lunch counter and other conveniences for the health and comfort of the workmen found in many places. Yet, if we are correctly informed, it is a shop where machinists like to work and where they stay as a general thing for long periods.

On the part of these machinists, also, it should be said that they show quite a different disposition from that sometimes manifested. There seems to be no objection to running two machines and in fact one man is successfully running several lathes and drawing good wages for his efforts.

The two facts that this company is doing a profitable business with a somewhat inferior equipment and that the mechanics employed by them are well pleased with the conditions as they find them, in spite of the lack of some of the modern conveniences are at least significant. One cannot help but think, however, that the one fact is but the complement of the other. The most profitable adjunct of a concern is a body of men who are so well pleased with their positions that they are ready to reciprocate by extra efforts when called upon to do so.

While we do not wish to be understood as decrying all that is modern and holding that all which is good is of the past, it cannot be denied that a shop like the one alluded to is a typical, old-fashioned shop in several respects and that in some of these it is ahead of some of the newer organizations concerning which we hear so much. The new shop has much that is for the better that those of the old never dreamed of. It has better light, heat and ventilation. It has lavatories and sanitary arrangements that were unheard of, even a few years ago, and many other conveniences, not to speak of the improved tools and methods for increasing the quantity and quality of the output. All these go to make the modern shop vastly better and more productive than the old-fashioned shop; and yet, it is very evident that these are not all, nor even the chief things desired by a mechanic. Fair and generous treatment, first of all, is what he desires. He wants to feel that he is a man with individuality instead of a machine, and any step taken in this direction will do more to make a machinist a valuable man for a firm to employ than any other one thing. On the other hand, no mechanic can expect such treatment unless he himself is ready to do, perhaps a little more than his share, if need be, toward bringing such a result about. If there could always be the mutual good feeling that we believe exists in the New England shop above referred to, the modern shop, with all its modern attractions, would be an ideal place in which to find employment. Some shops do at least approach such a condition, but many do not. Every one that does, however, is a powerful object lesson, and will help win over those that do not.

* * *

The largest locomotive in the world is stated to be one built recently by the Brooks Locomotive Works for the Illinois Central R. R. It is of the 12-wheel type and weighs 364,900 pounds complete with the tender and 232,200 pounds without the tender. The boiler is 6 feet 8 inches in diameter, the grate area 37½ square feet and the cylinders 23 x 30 inches.

# AMONG THE SHOPS.

## THE MANUFACTURE OF DIES AND DROP FORGINGS.

Drop-forging is a peculiarly interesting process to both machinists and blacksmiths, but one that is not very well understood by the great mass of either trades. It is a process in which some ingenuity and much experimenting have been required to bring it to its present state, as, not theory, but practical conditions and the peculiarities of the material being worked determine its limitations. It may quite properly be called "machine blacksmithing," as the work of the blacksmith is duplicated mechanically, but in a superior manner and at a rate that leaves no room for hand labor competition, when sufficient quantities of any one article are required to warrant the expense of the dies.

What makes drop-forgings more desirable to the manufacturer than a low first-cost is, however, the close approximation to uniform size that exists in the forgings when they leave the finishing dies and the homogenity of their material. In the manufacture of machines having interchangeable parts which are of a very complicated and irregular shape, the drop-forging plays an important part. The building of machines on the interchangeable plan is one factor that has contributed to bring the drop-forging industry so quickly into favor, as it is comparatively an "infant" industry. Something less than fifty years ago, Col. Colt adopted in a limited way the use of drop-hammers in the manufacture of the small parts to his famous firearms. The events that followed, culminating in the Rebellion, greatly stimulated the manufacture of firearms and, consequently, that of drop-forgings, but the principal development of the industry has been within the last quarter of the century.

Being considerably interested in "machine blacksmithing" and thinking that many readers of this journal might appreciate some information on the subject, the writer recently visited the plant of J. H. Williams & Co., at Brooklyn, N. Y., and there received not only many new ideas regarding the manufacture of drop-forgings, but some very refreshing ones on shop system and the management of employees.

The means employed for forming the hot and plastic metal into the desired shapes make drop-forging a somewhat hazardous occupation. A genuine desire on the part of the management to avoid distressing accidents has led to extraordinary precautions being taken to avoid them. The erection of safeguards for accident prevention is not, however, confined to the drop-forgings departments, but, as will be seen from a look at the double-page engraving, they are placed throughout the shops and in many places where the danger of accident is comparatively slight. This safeguarding of the employees' persons is not by any means confined to merely preventing mechanical injury, but the general effort is to promote their general health and welfare in many ways that will be apparent further on.

### Making the Dies.

The first step in the manufacture of drop-forgings is, of course, the making of the dies. A model of the part to be forged is usually whittled out of wood, if it be of a form not clearly shown by a drawing. Given this model, a scale drawing and the required weight of the finished forging and the die-sinker has the principal data required by him for making the dies. To this information should be added, however, the number of forgings required and the allowable limit of variation from the stated dimensions. If only a few hundred forgings are to be struck from the dies, they may just as well be made from a low grade of steel and need not be fully hardened. If, however, thousands of forgings be required, the dies must be made of the best steel and most carefully hardened to stand the test of protracted hammering. It is evident that the dies made for many forgings are more expensive in the first cost, but the cost per forging is usually far below that borne by the dies made for the smaller number.

The die-sinker determines, from his model, the best "parting line" for the forging in much the same way as does the patternmaker on the pattern for a casting, but the analogy between the two is comparatively slight as the conditions are radically different. The patternmaker can use cores and loose parts to make cavities and overhanging parts, but the die-sinker is practically limited to a die opening in two parts, which must be made to stand the roughest usage. When these conditions are considered, it is surprising to see the apparently impossible forms that are successfully drop-forged.

The outline of the piece to be forged is drawn on the surface of the die which has been coppered with a blue vitriol solution, thus causing the lines to stand out sharply. The metal is then removed in the manner that is most expedient for that particular example. If the outline be circular and of a shape similar to a cylinder-head, the most obvious way is, of course, to bore out the stock on a lathe. It should be stated that the die blanks are planed in pairs before die-sinking is started and the dove-tails for fastening the dies in the hammer are all finished.

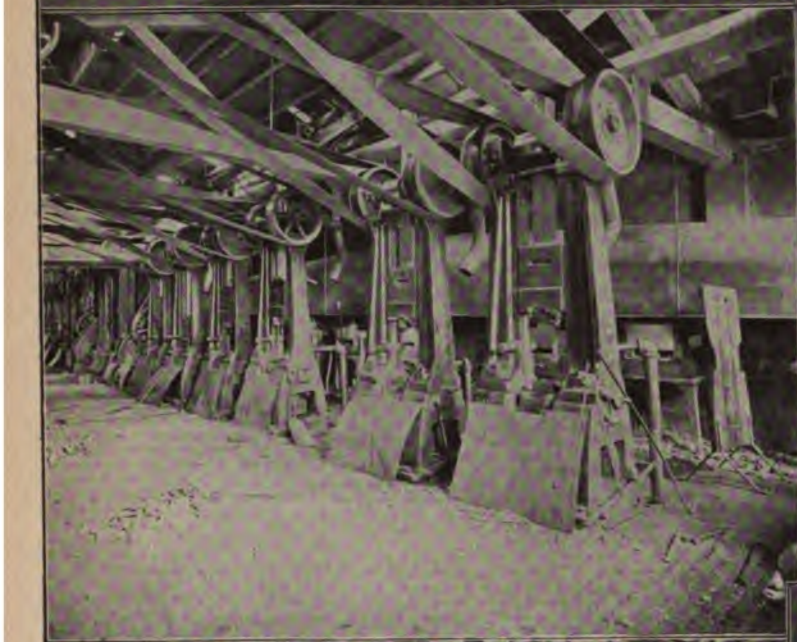
If the shape of the forging be such that other means are required for removing the metal from the die, the profiling machine readily furnishes a means for following the most complicated forms and cutting away the stock by means of milling cutters of various shapes and sizes. In case the piece to be forged be of a comparatively long and regular section, either the shaper or milling machine may be used, after the ends are worked out, as may be found most expedient. Drilling and chipping are commonly-used means for die-sinking, and, in almost any case, a liberal use of the file, riffle and scraper is required to finish the die to the required smoothness and regularity.

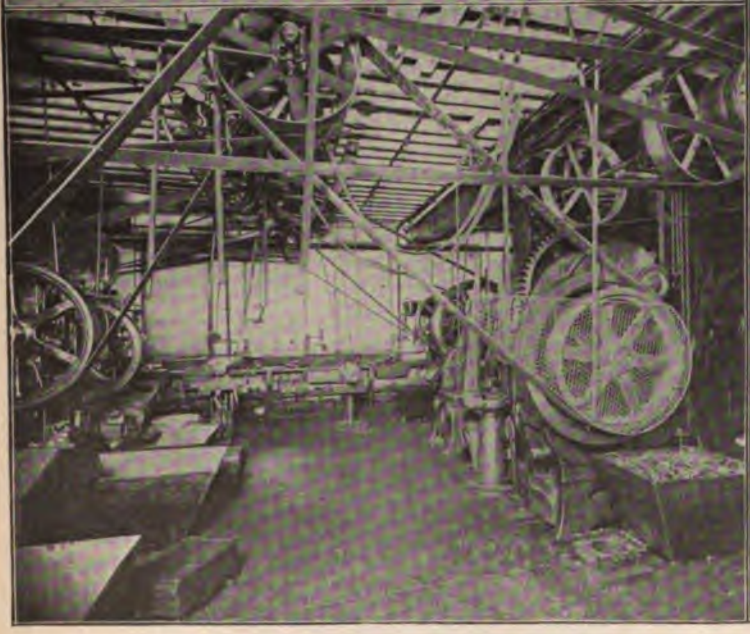
The forming of an irregular cavity in the face of a high-carbon steel die so that, when its mating die is matched to it, the shape of the inclosed space shall not vary from the specified dimensions more than two one-thousandths of an inch either way, is an operation of the highest order and one necessarily requiring time, patience and skill. After the die-sinker has formed the die to the desired shape, a "proof" is taken by filling the cavity with melted lead. If the forgings are to be made for a customer to his order, the proof is submitted to him before hardening the die. If any minor changes be needed, they are made and a shallow space cut in the face of each die around the cavities. This is for what is technically called the "flash of the die." As it is practically impossible for the drop-forge operator to form the billet of iron or steel into just the shape and size required for the forging, this space must be left for the overflow of surplus metal.

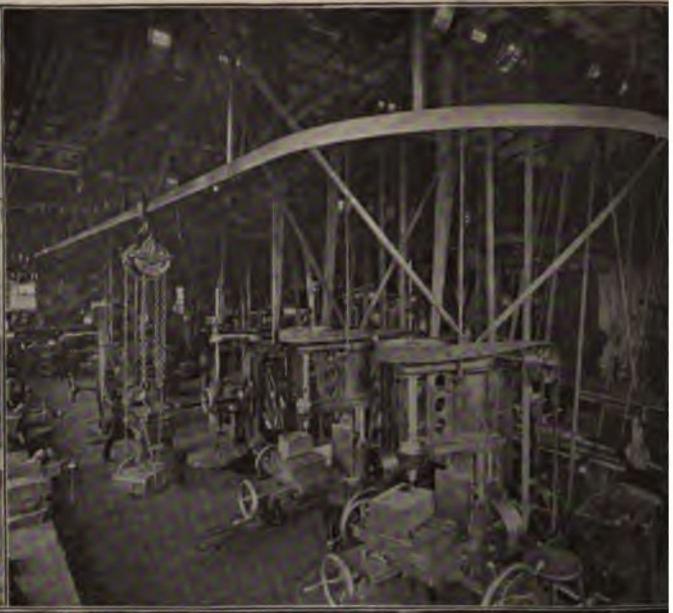
The overflow of metal or "flash" has to be trimmed off, after the forging operation has been completed, in trimming dies which are made in another department, as shown in the double-page cut. The trimming dies are made in male and female form, the upper part being the male die and the lower die the female. The male die is made of the outline of the forging through the parting line and with its face conforming to all the irregularities of the upper part of the forging to be trimmed. This is especially necessary on light forgings to prevent distortion of the pieces during the trimming operation. The female die is open at the bottom so that the trimmed forging can fall through it into a receptacle under the press. It is also made with its cutting edge conforming to parting line or flash of the forging for the same reason given for the shape of the male die. A female trimming die is plainly shown in the engraving at the left of the die storage cellar, leaning against the die racks. On the right, two pairs of dies for forging wrenches are visible.

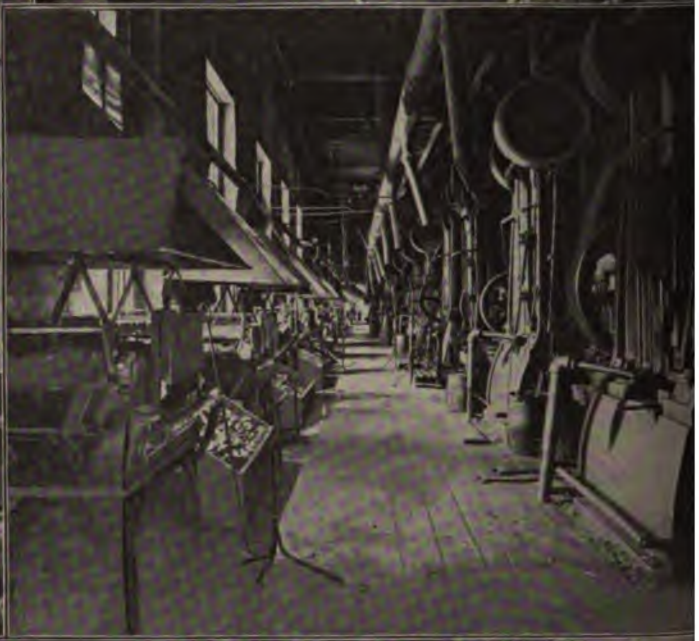
It will be noted from the views given of the die-making rooms, that the shaper and profiling machines are the principal machine tools used. An overhead trolley track, which shows in the die-sinking department, is found to be a very convenient means for transporting the heavy dies from the machines to the work benches on the sides of the room.

The dies are hardened, after the proof is accepted, in the hardening, case-hardening, annealing and tempering department which has furnaces in which the temperature is regulated by pyrometers. The tempering furnaces are furnished with permanent instruments, one of which shows in the form of a steam gage in the cut, but, for the other furnaces that require a much fiercer heat, a portable instrument is provided. The attendant thrusts the stem of the pyrometer through a hole in the furnace front and quickly ascertains the temperature of the furnace. It does









View of shops from the street showing the vines growing over the walls.

Auxiliary forge shop. The air pipes for cooling the men can be seen behind the hammers.

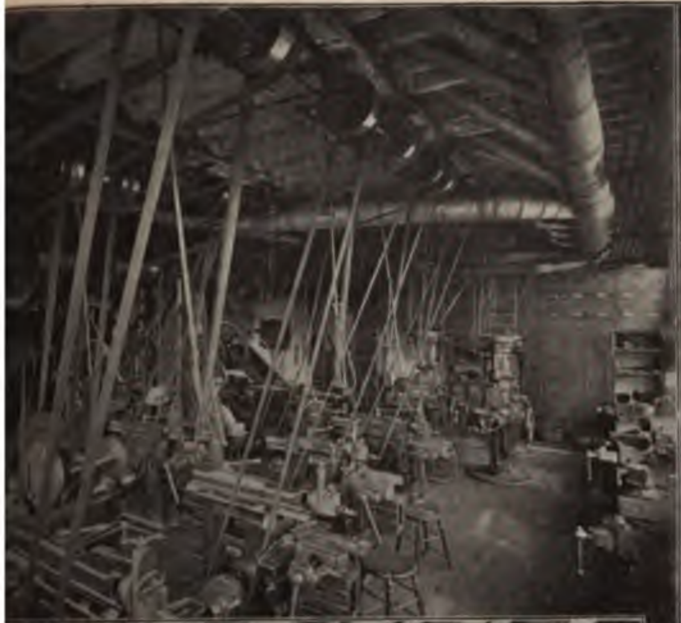
Trimming department. Press shown in the foreground with wire screen over the flywheel.

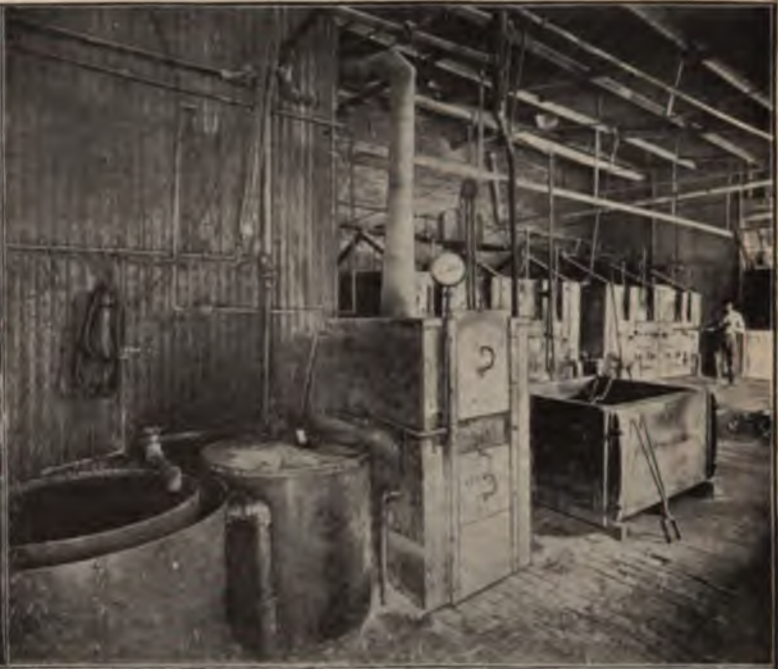
Die-sinking room. Profiling machines for die-sinking and trolley track for handling the dies.

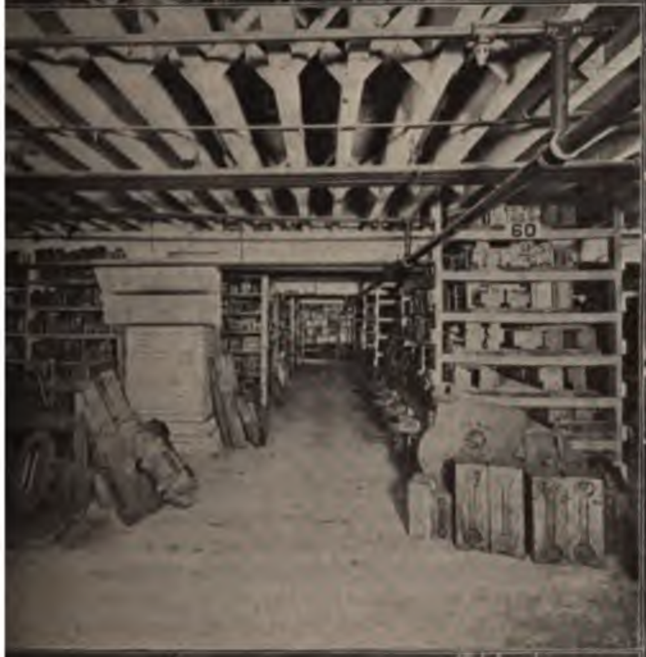
View of the main forge shop from behind the hammers. Air pipes for cooling the men and for blowing the scale from the dies.

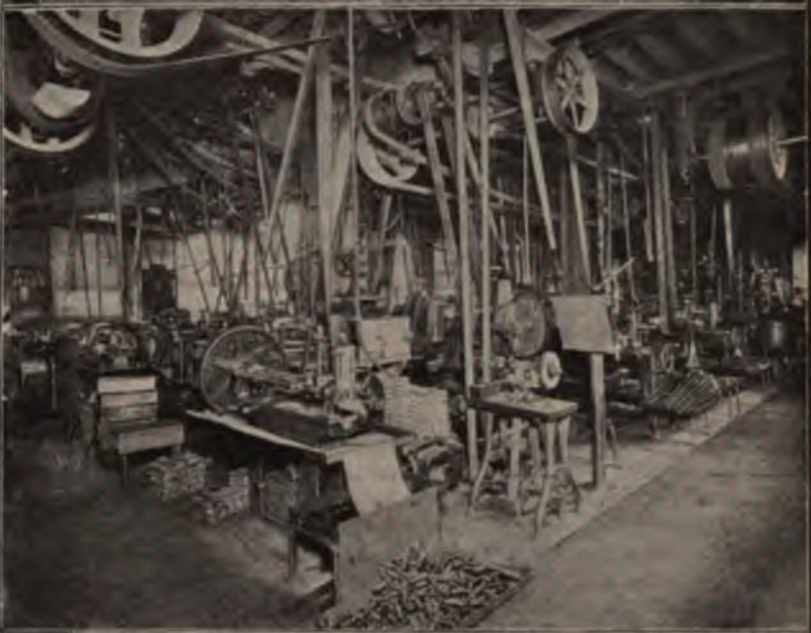
Pickling room for removing scale from the finished forgings.

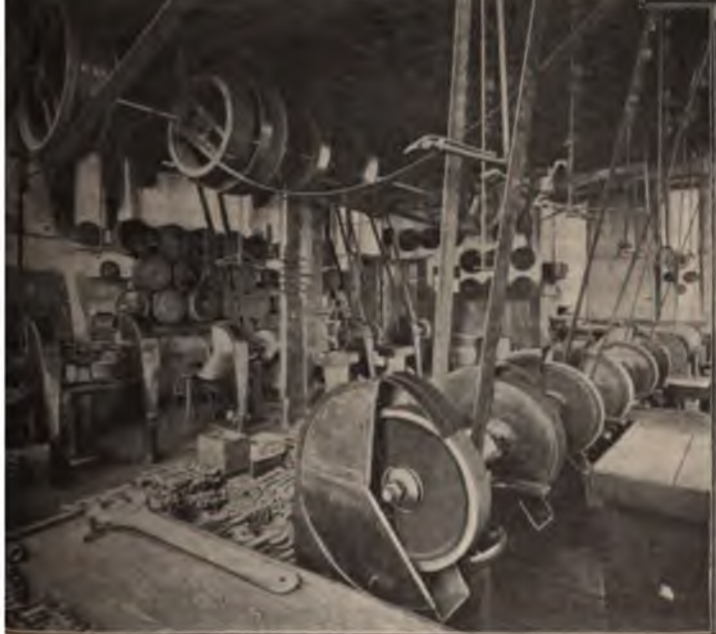
THE MANUFACTURE OF DROP FORGI

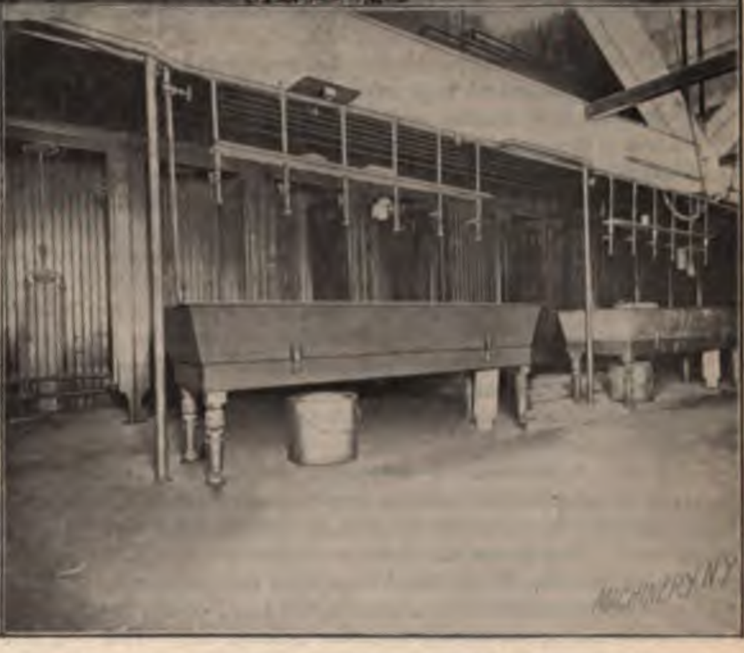












Trimming die room. The pipes overhead are the exhaust conduits from the polishing room above.

The die storage cellar. Nearly 8,000 sets of dies are stored in this room.

Polishing room with an exhaust head for each wheel.

Hardening, case-hardening, tempering and annealing department. Pyrometers used here for gaging the heat.

Finishing room with a broaching machine in the foreground.

View of the bath-room showing the shower baths and tubs for washing clothing.

E WORKS OF J. H. WILLIAMS & CO.

not require a great deal of acumen to perceive that such a method for determining the temperature of a furnace, in which high carbon steel is being heated, is far better than the usual guesswork plan. The permanent qualities of the dies hardened and tempered under these conditions fully pay for any additional expense incurred, with a handsome profit in addition.

### Drop Forging.

Having briefly followed the die from its rough state to a finished condition, we are ready to enter the drop-forging department and see them in actual operation. About fifty drop-hammers are in use in this plant, ranging from those having rams weighing 2000 pounds down to those weighing only 200 pounds, but the average weight of the rams most used is about 800 pounds. In the drop-forging rooms, of which there are two, we see forgings turned out that range in weight from 100 pounds to 1-16 of an ounce and covering the whole range of industrial art. We noted shoe-horns and cream separators, surgical instruments and parts of rapid-fire guns, pieces made in iron, steel aluminum, copper and tobin-bronze for manicure sets, deep well pumps, pencil erasers, projectile tips, golf irons, etc.

The auxiliary forge shop is in a building across the street from the main building shown in the engraving and in it are made the lighter and cheaper forgings. The main forge room, shown in the second view, contains the heavier hammers. The view shown is taken from a photograph of the alley between a row of drop-hammers and the furnaces in which the metal is heated. A pipe is shown sticking up through the floor at each hammer with a nozzle directed towards the dies. A current of compressed air passes from the nozzle against the piece being forged and blows away the scale as fast as formed. The operator raises the metal from the lower die after every drop of the hammer, so that the scale on the under side may be swept away and thus prevent pitting and roughing the forging. Of more importance from a humanitarian view, however, is the pipe, with the short sections extending downwards, that can be seen overhead. This is a pipe supplied by a blower and discharging a current of cooling air on the men as they work at the hammers. The conditions that usually prevail in a forge shop during hot weather are very trying and it is often necessary to shut down during the hottest weather as the men are unable to stand the labor and heat. With the arrangement shown, a cooling blast is directed as the workman may desire, the short section being connected to the horizontal pipe by a universal joint so that it can be swung to any desired position. The writer was informed that during the hottest summer weather of 1899, it was not necessary to shut down, an occurrence before unknown. The temperature behind the hammers was from 10 to 20 degrees less than in any other part of the plant, so that the forge men had about the coolest place to work in.

The drop-hammers are of the board type, that is, the head is attached to a maple board which is gripped between friction rollers and raised by them until a predetermined height has been reached when it is released by a trip. Strange as it may seem, these boards have an unaccountable way of breaking short off and sending splinters and fragments flying in a dangerous fashion. To prevent accidents from this cause, each drop-forge man is protected by an overhead screen to catch any broken pieces in case the board breaks on his machine.

In some instances the forgings are required to have a very smooth finish as they leave the dies. In such cases, water is sprayed on the forging just before being completed, which dislodges the thick scale or oxide formed and leaves the piece with a thinly oxidized surface that requires very little work to form a highly finished surface.

### Pickling the Forgings.

The scale on the greater part of the drop-forgings is removed, however, by being immersed in a pickling bath of water and sulphuric acid. The pieces are thrown in the metal baskets shown and lowered into the vats until the scaling process is completed. One of the workmen has rigged up the labor-saving device shown for raising the baskets from the pickling vats. This is mentioned to illustrate the efforts made to encourage the men to originate ideas for facilitating any operation. Suggestions are listened to, and, if found of value, are adopted. The truck for transporting the forgings to and from the pickling room is a convenient affair. Four trays or buckets are pivoted on the truck so that, when filled with pieces, the center of gravity will be behind the pivot or opposite the spout end. A sheet of wrought iron is pivoted to the top of the truck and turned up to support the spouts of the buckets and is hooked in this position when transporting forgings. When a department is reached where the forgings in one bucket are wanted, the sheet iron piece is unhooked and turned down. The bucket can be easily turned to discharge its contents without disturbing the contents of the others. In this way all of the buckets are unloaded where wanted without the necessity of handling individual pieces.

### The Trimming and Finishing Departments.

After the forging has been pickled, it is necessary to trim off the fin or flash of the dies. In some cases, however, the forging is hot trimmed, immediately after being formed. If it is to be hot trimmed, the press and trimming-die are located in the drop-forging room alongside of the hammer and the trimming is effected after the forging operation is completed, but while the piece is still hot. When the trimming is to be done cold, the forgings are taken to the cold trimming department shown in the engraving. An elaborate guarding for a press flywheel may be seen in the foreground. The trimming operation may complete the forging ready for shipment, or it may need to go through other operations as may be specified by the customer. Quite an extensive line of machine work on forgings is done to order, but the greater part done is on regularly manufactured tools which are finished ready for the trade.

In the finishing room considerable broaching is done on pieces like bicycle cranks. The machine shown in the foreground operates by pulling the broach through the part to be broached. A stream of oil is directed on the piece as the broach is pulled through. The broach is held in a carriage mounted on two circular guides at the sides and connected to a long screw on which is engaged the large internally threaded gear. The operator has to release the broach from the head for each piece to be broached and thrust the shank of the tool through the drop-forged hole. The smoothness and accuracy of the work are such that nothing more is required to be done to the hole when a piece is fitted into it. Holes are also broached tapering when required.

### The Polishing Room.

In the view of the polishing room, we see that each emery wheel and polishing head is provided with an exhaust head for removing the particles of dust and metal from the air as fast as formed. So effectually is this done by the exhausting system, that the room is as endurable as any other in the works. There is a total absence of dust and lint, which when flying through the air are so injurious to health and which make the average polishing room a breeding place of disease. The elaborate system of piping necessary for the polishing room shows overhead in the trimming die room. The heavier particles are discharged in a settling chamber by centrifugal action, while the lighter and volatile products escape with the exhausted air on the roof.

### Die Storage, Fire Protection, Etc.

The dies are stored in the basement and here we find nearly 8000 sets of forging and trimming dies, of which over 5000 are in active use. The system for keeping track of the dies is quite simple. The racks are numbered, as will be seen in the engraving, and the shelves are lettered. Along the face of the shelves are stenciled the numbers of the dies which correspond to the number stamped on the dies themselves. A type-written list is posted which shows at a glance in what rack and on what shelf any number of die may be found, so that among the thousands of dies stored, any die can be produced without delay after the number is given to the man in charge.

To protect the building and its contents from fire, a most elaborate system has been worked out, in which certain men in each department have certain specified duties. A fire pump is located in the engine room and is always under steam, so that it can be started instantly. It is the duty of one person in each department to send in an alarm to the city fire department in case of fire in his vicinity, and others have the charge of the hose and know what their duties will be in case of such an emergency. The sprinkling system is also installed, as will be seen by the overhead pipes in the die cellar, and, although the plant is not strictly fireproof, the danger from a disastrous fire must be very slight. That this is an important consideration, to a customer has drop forgings made to fulfill certain contracts, goes out saying. Oftentimes the failure to obtain certain small s of machines for filling large contracts causes a loss many s the actual value of the parts themselves.

or the comfort and convenience of the employees, the exive bath rooms shown are provided which are appreciated hem, especially in the heated term. Tubs are also provided washing the outer garments of the men, so that if desired can always have clean outer clothing. Among other helps to workmen, we may add that a mutual aid association is in ve operation for the relief of distress in case of sickness or dent. An insurance on workmen's tools to protect them n loss in case of fire or theft is another of the minor schemes appeal to the philanthropically inclined.

* * *

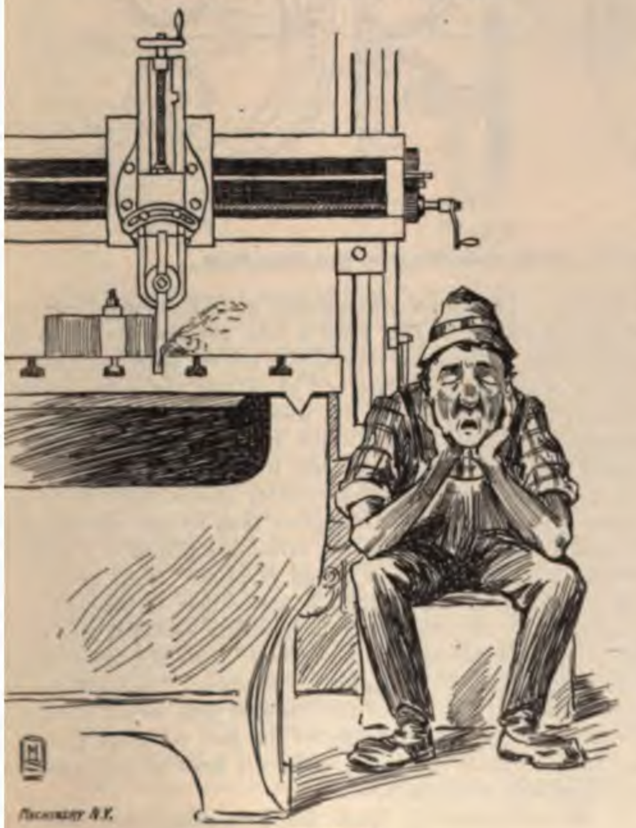
he following historical facts about the growth of marine ineering in the early years of the present century are reed by "The American Shipbuilder" to have been given by rles H. Haswell, the well known engineer. John Stevens, Hoboken, N. J., in 1809, applied slides and a crosshead to le the piston rod of a steam engine. In 1824 James P. Al introduced the Woolf engine, the compound of the present The first introduction of steamboat towing was made in by a New York company. In 1826 a fan blower was introd by Robert L. Stevens. In 1837 the first steam launch was gned and directed by Charles H. Haswell, Chief Engineer S. Navy. In 1839 Francis B. Stevens invented and patented double eccentric cut-off; the same year Edwin A. Stevens gned and operated a closed fire-room. In 1846 Captain John sson designed and applied a surface condenser to the engine United States revenue cutter. In 1848 Mr. Pierson imed upon it, and soon after Chief Engineer William Sewell, S. Navy, further improved the construction, and in the same Frederick E. Sickles devised the application of steam to steering gear of a steamer.

* * *

common sewing needle held in a suitable handle makes an llent scriber for accurate work. It is so cheap that grindis unnecessary, as, when dull, it can be simply replaced by a one. The point on a needle is ground by an expert and is uperior to anything possible by the ordinary machinist.

* * *

## SHOP TERMS ILLUSTRATED.


Machinery N.Y.

STEADY REST.

## GAS ENGINE DESIGN.—4.

### CYLINDER HEADS AND VALVE ARRANGEMENT.

E. W. Roberts.*

There are so many different methods of arranging the valves of a gas engine that it would be unpractical to show one design which would embody in itself the entire range of general practice in this respect. If the reader will take the trouble to inspect the catalogues of a few of the two hundred or more gas engine builders in the United States alone, he will find among them engines in which both the inlet and the exhaust valves are placed in the cylinder head. In others he will see that one valve is in the cylinder head, while the other is in a special casting or box bolted to the side of the cylinder or cast in one piece therewith. In still another class both valves are in special compartments by themselves on the side of the cylinder, while quite often the same compartment answers for both valves. Again the valve-boxes will be found not only on the sides, but on the top and on the bottom of the cylinder, while occasionally the stem of the valve makes an angle of 45° with a plane passing through the center of the crankshaft. In view of the wide range of the practice in this respect, the writer will show two or three examples of valve arrangement and point out what appears to him to be the features that require the most attention.

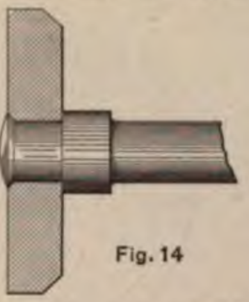


Fig. 14

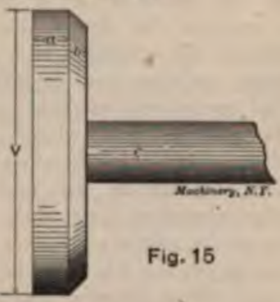


Fig. 15

Gas Engine Valves.

There are, in the design of all valves and their accompanying mechanisms, several points of importance that should be kept in mind at all times. Quick opening and closing of the valve is desirable in order to prevent useless work being done by the piston, either by drawing the gases in or by driving them out through unnecessarily contracted openings. This rapidity of action is limited in practice by the nature of the valve-operating devices, for, if too rapid a motion be attempted, the cam will, when opening the valve, strike the roller such a blow as to make a disagreeable noise, and when the valve is closing, the action of the valve spring may not be rapid enough to permit the roller to follow the cam. Thus a blow will be struck by the roller as soon as it catches up with the cam. It is usually desirable to sacrifice a little of the power of the engine in order to reduce the noise of the valve mechanism. The exhaust valve, being surrounded as it is at each working stroke with the hot products of combustion, is liable to excessive wear unless means is provided for keeping it cool. Hence it should be the invariable rule to jacket the valve seat by so arranging the water jacket that it will surround the valve opening. It is not neccessary to jacket the inlet valve, as this valve is surrounded at every suction stroke with the comparatively cool, fresh mixture.

With but few exceptions, all gas-engine valves are of the mushroom type shown in Fig. 14. The inlet valve may be made entirely of wrought iron or steel, but experience has shown that it is necessary to make the head of the exhaust valve of cast iron, as this material will best withstand the abrading action of the hot gases. The valve stems are usually made of good mild steel. In the case of these valves having cast iron heads, the head is bored to fit the stem and the latter is riveted in place, as shown in Fig. 15. Should the inlet valve be operated by the suction of the engine piston, it should be as light as practicable and the construction of the valve in one piece permits it to be lighter than when of the built up type. It is also desirable in such a valve to avoid a long stem or any other feature that will add unnecessary weight. Regarding the advisability of using an induction valve operated by the suction of the piston, there is much discussion, particularly as to its practicability on large engines. There is no question that it produces a slight wire-drawing on the suction stroke, for the reason that there must be a partial vacuum in the engine cylinder before the valve will open. Of course, there is always a small amount of power required to open the valve by means of cams, levers and similar mechanism, and this operating mechanism is an additional expense in the manufacture of the engine. As to the advisability of using such a valve, the writer will permit the reader to judge for himself, and merely remark that, while the valve has been abandoned by some, it is nevertheless in use on several successful engines. The mechanically operated induction valve is, I believe, the one in most general use on large engines.

The proportions of the gas engine valve and its stem, as shown by Fig. 15, are as follows. Taking the diameter of the outside of the valve as a unit and calling this diameter v, the remaining proportions are:

$$a = 1/8\ v \qquad (15)$$

$$b = 1/16\ v \qquad (16)$$

$$c = 1/5\ v \qquad (17)$$

Since the angle of the valve seat is 45°, it follows that the diameter d of the valve opening is 1/16 less for each side or 7/8 that of v.

$$\text{Hence } d = 7/8\ v \text{ and}$$

$$v = 1\text{-}1/7\ d \qquad (18)$$

It should be noted that these proportions are intended as a guide merely, and that the designer is expected to use his judgment, to a certain extent, in their use, employing sizes that are nearest to those given and also considering c, when properly guided, as a column under the conditions imposed by the mechanism. The maximum pressure at the opening of the exhaust valve is seldom in excess of 100 pounds per square inch, while the usual pressure at this point of the cycle is in the neighborhood of 40 pounds. The proportion of c given above is suited to long stems, such as are used in engines wherein the stem reaches to a point near the crank-shaft. For short stems this dimension may be proportionately reduced. In the case of light inlet valves operated by suction, the dimensions may be made equal to or even less than b, especially when these valves are made entirely of wrought iron or steel. It is also to be noted that the diameter of the stem could be lessened in this case as the stem is under only a light tension. In small engines this diameter could be safely made as small as 1/6 v and in large engines about 1/7 v.

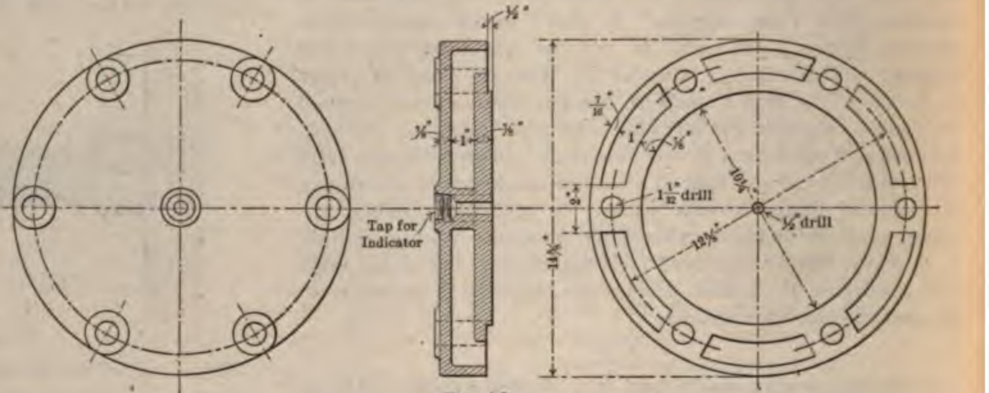


Fig. 16

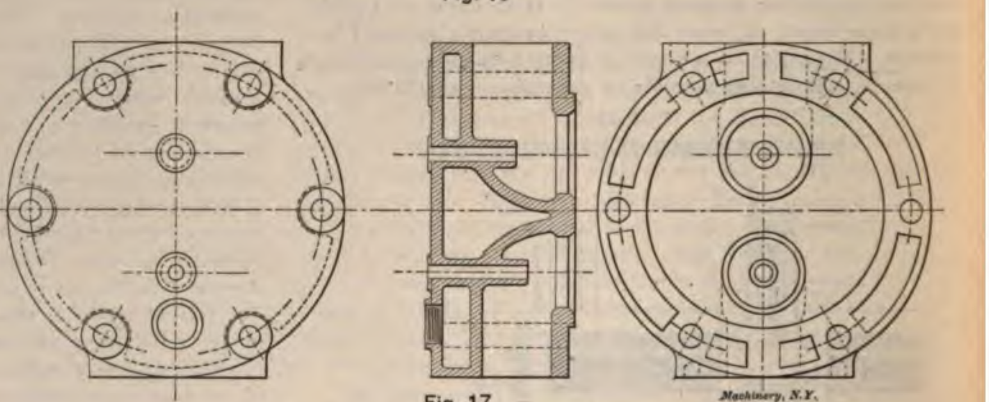


Fig. 17

Details of Cylinder Heads, either with or without Valve Seats.

The stroke of the valve was given in article 3 as 1/4 the diameter of the valve opening, for an area equal to the area of the passage. In a series of engines recently examined by the writer, the valves had, in a majority of the engines, a lift much less than this, with a result that was plainly shown on the indicator diagram in wire-drawing of the charge. It would perhaps be best to exceed this proportion a small amount, say 1-16 inch or so, in order to allow for any lost motion which may occur in the operating mechanism.

A form of cylinder head, usually employed when the valves are placed on the side of the cylinder, is shown in Fig. 16. The head is designed for a ten-inch cylinder with a 1¼ inch counter bore. It will be observed that the head is water-jacketed, and that the thickness of the metal in the head bears the same relation to cylinder diameter as the walls of the cylinder and the water-jacket when calculated by the formulas in article 3. Thus the thickness of the inner wall is in round numbers ⅞". The thickness given by Formula 11 being 10 × .09 = .9 inch and since ⅞ inch is .875 inch, it has been chosen. In the same manner the depth of the water-jacket is found by Formula 12, to be 1 inch and the thickness of the outer wall being ½ the inner wall, it will be 7-16 inch. Calculating the necessary size of the cylinder head studs on the basis of 400 pounds per square inch maximum pressure, it is found that six one-inch studs are required. The six studs on a 12⅝-inch stud circle give a distance between centers of 6⅜" or ⅜" over the six-inch limit. This scarcely induces a sufficient departure from the rule to make the use of eight studs imperative. It will also be seen that the stud circle is a little within the center line of the water-jacket. This is necessary in order that the nuts may have sufficient bearing on the cylinder-head. It will be found a convenience, in a cylinder-head of this design, to drill or core a small hole through the head, as shown, and to drill and tap the head on the outside for the indicator connection.

It is best at all events to add a small column of iron in the center between the two walls of the head, even should it not be desired to drill it for the indicator, as the column will serve to stiffen the head without materially adding to its weight. The head shown is intended for a horizontal engine. In case it should be employed for a vertical engine, a hole should be drilled and tapped for the water outlet pipe as shown in Fig. 17.

To return to the subject of valves, a cylinder head designed for containing both the inlet and the exhaust valve is shown in Fig. 17. This is an arrangement quite frequently employed on vertical engines. This head is also designed for a ten-inch cylinder and the principal dimensions are the same as in Fig. 16. A close study of this figure will show that the valve openings are nearly surrounded by the water space. While it is not necessary to jacket the inlet valve, the core has been continued around the latter in order to save iron and also to retain uniformity in the design. In the cylinder shown, there is no provision for removing the valves other than to take off the cylinder head. Quite frequently the valves are placed in a separate casting and this casting is bolted in place. It is, however, a difficult matter to arrange these boxes so that, in the case of the exhaust valve, the valve may be properly jacketed and at the same time perfectly tight in every way. This the writer knows, from experience with an engine of this class. The small amount of room at the disposal of the designer will, in all likelihood, compel him to reduce the sizes of the port openings below the size best for good effect, and make the head an expensive one to cast as well as to machine.

In the accompanying figure the dimensions have been purposely omitted for the sake of clearness. Those dimensions not given on Fig. 16 are as follows:

Exhaust valve, 3½ inches.
Inlet valve, 3 inches.
Wall between passages and water space, ½ inch.
Exhaust valve stem, 11/16 inch.
Inlet valve stem, ⅝ inch.
Tap holes for exhaust pipe flange (cap screws), ¾ inch tap.
Tap holes for inlet pipe flange (cap screws), ⅝ inch tap.

The head is also tapped, as shown, for the water outlet pipe. The air inlet pipe is sometimes screwed directly into the opening in the head or valve-box. It would hardly be advisable to do so in the present case, as it would cause much extra work when taking down the head. For the same reason it would be best to use cap-screws instead of studs for bolting on the pipe flanges.

It is occasionally the practice, in the design of horizontal engines, to build the cylinder head so that it contains a part, if not all, of the compression space, to place the pipes at the end of the cylinder, and to put the valve stems through the sides of the head. While this arrangement gives a neat appearing design it would probably be a greater convenience to the repair man to make the cylinder head as light as practicable. Unfortunately the repair man is in many instances entirely overlooked by the designer, and the owner of the engine has an unnecessary amount of expense every time the engine is in need of repair.

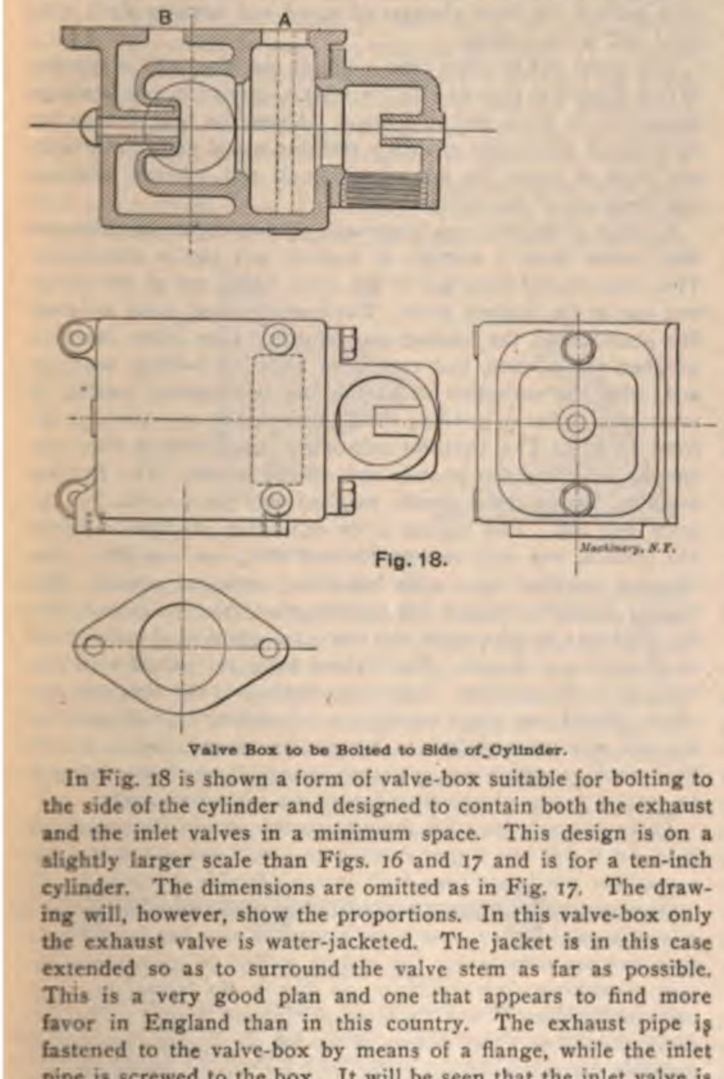


Fig. 18.

Valve Box to be Bolted to Side of Cylinder.

In Fig. 18 is shown a form of valve-box suitable for bolting to the side of the cylinder and designed to contain both the exhaust and the inlet valves in a minimum space. This design is on a slightly larger scale than Figs. 16 and 17 and is for a ten-inch cylinder. The dimensions are omitted as in Fig. 17. The drawing will, however, show the proportions. In this valve-box only the exhaust valve is water-jacketed. The jacket is in this case extended so as to surround the valve stem as far as possible. This is a very good plan and one that appears to find more favor in England than in this country. The exhaust pipe is fastened to the valve-box by means of a flange, while the inlet pipe is screwed to the box. It will be seen that the inlet valve is placed in a separate casting bolted to the end of the valve-box. This arrangement is necessary in order that the valves may be removed and that the valve seats may be machined. The exhaust valve may be easily taken out through the opening for the inlet valve case. The joint between the two castings should be packed with asbestos packing. If a union be placed in the first joint of the inlet pipe, it will be found a great convenience when taking the box apart in case it is, at any time, necessary to grind the valves. Proper openings should be cored in the cylinder for connecting the interior with the opening A and the opening B to the water-jacket. It may be found necessary to connect the water outlet from the cylinder to the top of the valve-box by means of a separate pipe in case the circulation is poor in the exhaust valve jacket. This will not be likely to occur unless a closed circulating system is employed. The designer should provide bearings for the valve stems having a length from three to five times the diameter of the stem, in order to prevent leaks through these bearings. Wear is especially to be guarded against about the exhaust valve stem.

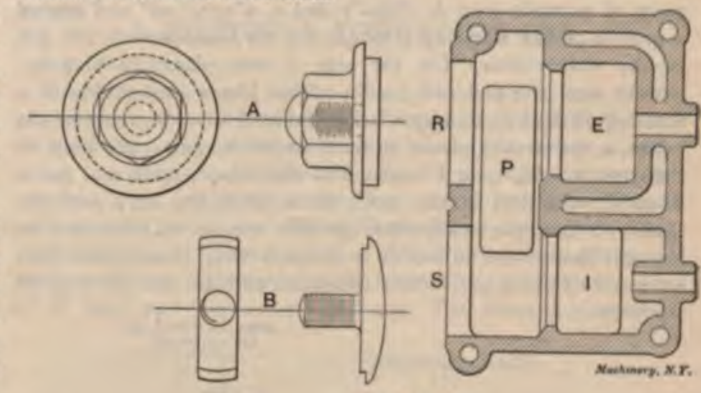


Fig. 19.

Section of Valve Box.

Fig. 19 is a cross section of a valve box in which both valves are placed with their stems parallel and pointing in the same direction. In this case the inlet and the exhaust pipes are attached to the cylinder, the gases passing into and from the cylinder through openings cored in the cylinder. The mixture enters through the opening I, passes through the valve opening shown and thence downward into the cylinder through the port P. The exhaust passes out through P and by way of the exhaust valve opening to the exhaust port E. In order that the valve seats may be machined and the exhaust valves removed, it is necessary to provide the openings R and S. These openings are closed by means of the cap A and the clamp B, the cap A having a ground joint which is fitted to a similar joint on the valve box. It should be noted that, in this case, there are four openings in the base of the box. These are the openings P, E, I and an opening, not shown, from the water space surrounding the exhaust valve to the water-jacket of the cylinder. This valve box is especially adapted for engines in which both valves are mechanically operated from a cam-shaft near the crank-shaft. Valve boxes of this type are employed on both horizontal and vertical engines. When making the valves, a screw slot is quite frequently milled in the valve head in order that the valves may be reground by using an ordinary carpenter's bit brace and a screw-driver bit. The design shown in Fig. 17 is best adapted for engines in which the inlet valve is operated by the suction of the piston.

It is well for the designer to keep the following points in mind at all times. Always jacket the exhaust valve. Remember that the valves must be removed occasionally, and that the design should be such that they may be taken out without tearing the entire engine to pieces. Don't cramp the passages, but keep them always of the same area, and make this area at least as large as that given by the formulas, wherever possible. Make the valve stem bearings of a generous length even if they do look "awkward."

* * *

It has been suggested that the ideal fly-wheel would be one that was arranged to give up or absorb energy more rapidly than is ordinarily done, because of the increase or decrease of the speed of the engine. One solution to the problem, which is interesting, even if not practical, is to have the wheel made with heavy masses of metal arranged to slide on the arms. Normally these masses of metal would be constrained toward the center by means of springs, but when the speed of the fly-wheel increased they would fly outwards and thus absorb energy, because of their increased velocity at the greater distance from the center. When the speed of the fly-wheel decreased these masses would come towards the center and so give up their energy.

* * *

The official opening of the Paris Exposition will take place on Saturday, April 14th, 1900.

# LETTERS UPON PRACTICAL SUBJECTS.

## AN INGENIOUS SCHEME—READING ADVERTISEMENTS ETC.

*Editor* MACHINERY:

We had about 10,000 drop forged keys that were about .010" or .012" too wide. It looked as if it would be a big job to file all these keys to size, but we did not have to file them. I took a piece of wrought iron A, Figs. 1 and 2, 2"x2½"x6" and planed a groove on the side and a tongue on the bottom to fit the slot in the shaper-table. On the side I also planed a diagonal groove near the end and put in a tool like a side tool with a screw (not shown) to adjust it for width of key. In front of the cutter, a spring was placed to hold the keys against the back of the groove. This rig I fastened to the shaper-table and put a piece of tool steel in the tool-post to push the keys past the cutter. When it was adjusted, the boy was set to work and he brought those keys to size in a comparatively short time. The keys were for an agricultural machine and did not have to fit sideways.

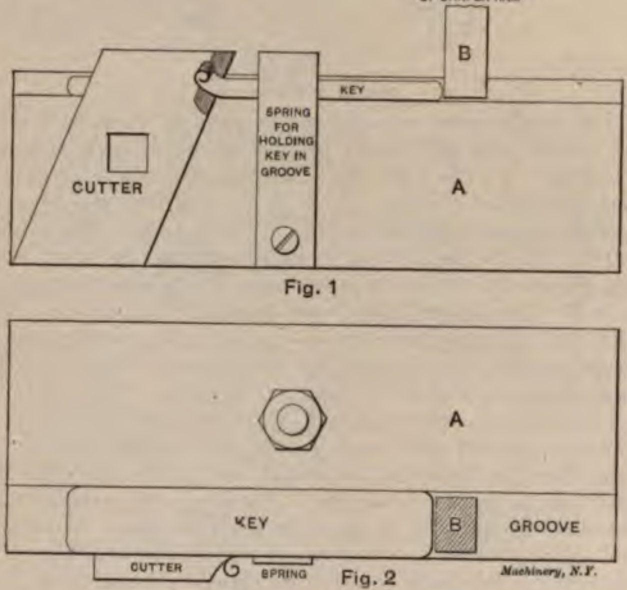

STEEL BAR IN TOOL-POST OF SHAPER RAM
B
KEY
SPRING FOR HOLDING KEY IN GROOVE
CUTTER
A
A
KEY
B
GROOVE
CUTTER
SPRING
Machinery, N.Y.

Fig. 1

Fig. 2

Rig for Trimming the Sides of Keys.

We often see the assertion: "It pays to advertise." I say, "It also pays to read advertisements." In the November issue of MACHINERY there was an advertisement of an arbor press. We make an agricultural machine that has six drive fits in it. I had been trying for some time to think of some way to do this work faster and also avoid the breaking of so many castings. As soon as I saw that advertisement I said, "There's my machine." I called my employer's attention to it. He ordered the press and now you could not get that press out of the shop for five times what it cost. It has paid for itself many times over in the amount of breakage it prevents.

Mr. Editor, can you tell me why small shops do not practise economy as well as large shops. I venture to say that small shops lose, lend or destroy five times as many small tools, to a man, as large shops. One, and, perhaps the main, reason is the absence of the tool room. Watch a man finish a job in a large shop and you will see him carefully put away every tool. Not so in the small shop. There he will leave them just where he happens to get through with them. I believe a tool room would pay in small shops even if only one man worked in it. I worked for some years in a small shop and quite a number of small tools came under my charge. When a fellow workman wanted to use any of them, I impressed on him the fact that it was a good thing for his health to return those tools as soon as he was through with them. My tools came home; the others were almost always lost.

I believe I have a new idea about selecting gears to cut threads. First, all of the factors in the screw to be cut must be in the lead screw or in the driven gears, whether single or compound. Second, the factors of the lead screw must be contained in the drivers. If you want to cut 2½, 5, 7½, 10, etc., threads per inch, and your lead screw is 5, then any gears that have the ratio 2:1, 1:1, 2:3, 1:2, etc., will effect the desired result. If the lead screw is some other number (not a multiple of 5), then one of the driven gears must be a multiple of 5. To cut fractional threads, reduce the number to an improper fraction and see if the gears and lead screw contain all of the factors of the denominator. Very few lathes will cut 17, 19, 23, 29, etc., because it is not practicable to use these prime factors. If the gears and screw do not contain all the factors, the job cannot be done and it is useless to try.
W. A. BRIGHT.

Decatur, Ill.

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## HIGH AND LOW PRICES.

*Editor* MACHINERY:

The experience of Oberlin Smith in purchasing cranes, related in the February issue of MACHINERY, is a common experience to those who have much to do with buying machinery. Such an experience is very perplexing to the buyer in some cases, because there is a strong suspicion that the cheapest offered is much inferior in some unknown way, and yet the price may be due only to superior shop economy and business management. Recently I had to make a selection of an emery wheel stand, of which the specifications were: Capacity for two wheels, cone pulleys for three changes of speed and counter shaft with tight and loose pulleys.

This could not be other than a simple machine, with a spindle, having flanges at each end for the wheels, carried in two bearings supported by some sort of a stand. About the only chance for variation in the design of such a machine would be in the weight and style of stand, the size of spindle in and between bearings and the sizes of the pulleys.

As time of delivery was important, price and date of shipment were asked from a number of makers and twelve responded. The prices varied from $45 to $90, there being one at the lowest and one at the highest price. The lowest priced stand weighed 650 pounds and the highest 900 pounds. One other machine weighed 900 pounds, had two-speed cones, self-oiling bearings and, with the exception of having but two speeds, seemed in every way to be as good as the highest priced one, but was offered at $75. The cheapest self-oiling machine had also two speeds, weighing 600 pounds and offered at $66. The lightest machine, having three speeds, weighed only 500 pounds, but the price was $66. The highest price self-oiling machine weighed 810 pounds, had only two speeds and the price was $80. The cheapest machine was a trifle less than 7 cents per pound. The highest machine weighed 250 pounds more than the lowest, and the difference in price made this increased quantity of metal come at 18 cents per pound. The highest price per pound was 13.2 cents for a $66 machine. I have no doubt that the cheapest machine offered was good enough for all ordinary grindings, but the one selected cost $56, or 8 cents per pound, and is a well built machine, which was preferred because it was better adapted to receive a special grinding fixture we wished to apply.

There is much food for thought in this experience, small as it is, for it was not a special machine which was called for, but a machine which has been built in considerable numbers by all makers of such machinery, and which can require but little in the way of special tools for its manufacture. There has been ample time and opportunity for the makers to find by experience the cost of making such machines, so that to the buyer the vivid contrast between 7 and 13 cents per pound seems to be entirely unjustified. The makers of the $66, or 13-cents per pound machine, have a wide reputation and are one of the oldest established firms manufacturing this class of work, but, after examining and comparing their design and price with others, it is difficult to see what would induce any one to buy their machine when a well built one weighing 200 pounds more, can be had for $10 less, or a self-oiling machine weighing 100 pounds more can be had for the same price. To the buyer it would seem impossible that the great difference shown is due to variation of actual labor and material cost.

From a manufacturer's view the case looks different, as there are several factors which, if combined, would account for the t difference in price. To begin with, it is difficult to tell just it costs to build and sell a machine. The wages cost and cost of materials purchased may be found nearly enough, the proportion of general running cost, advertising, taxes, ance and office expenses to be charged against a machine t of machines manufactured is a factor difficult to determine any accuracy. After figuring as closely as possible the re- must be refined by experienced judgment. When we add to the difference in design and workmanship, the difference onomy of shop and business management and finally the rence in profit, figured all the way from 15% to 50%, it is so difficult to see the cause of the great variation in prices. ve no doubt there are some shops among the lot mentioned e they could not have built the emery grinder for $45 and any profit on it, but others could have built it at a profit % to 20%. The average price of the twelve submitted bids $68.60 each. One striking fact about the matter is that ly all the twelve firms in question are thriving and pros- us, which shows that there are many machine buyers or who are not tempted by low prices. **Bell Crank.**

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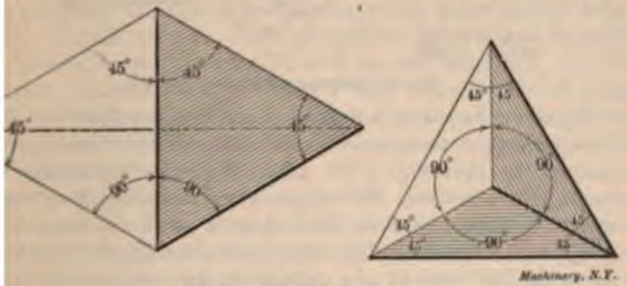
## SQUARING PARTITIONS—IMPROVISED TRAMMEL.

r Machinery:

e have recently had to get up a good many cases, having y fitted partitions which needed to be exactly at right angles the back and sides of the cases and at specified distances t. They were not gained in but held in by sprigs driven om the outside through the holes of the cases. In order to time and insure absolute equi-distance, I got up a rig which ted all three adjustments at once and had the great merit ing rapidly and cheaply made and easily used. It consists three-sided bottomless pyramid of sheet-iron, having a h of side equal to the distance of the partitions from each and from the ends of the cases. The three sides of which composed are right-angled triangles; all three of the right s coming together to make what the trigonometrician d call a "trihedral angle" and the joiner, a "solid angle." rig is roughly shown in the accompanying sketch, in per- ive, and may occasion some comment as to how three 90° s at the tip fill up the whole 360°. The answer to this is they do not, the lines forming the edges of the angles or ides of the triangles being fore-shortened, the same effect observed when one views a box corner "point on."



For Squaring Partitions.

e use of this rig about doubled the rate at which the par- s could be put in, as compared with the old way of squar- nd scribing.

Machinery, N.Y.

An Improvised Trammel.

e had occasion recently to transfer some important di- ions to fill in on six rough drawings in a repair case e no metric or other measure over a meter long was obtain- and those which were to be had were of the folding "grass- er" kind. I took three wine corks, three needles and a iron rod about a centimeter diameter and made holes cross- through the corks so that they would slide a tight fit on od. Then I stuck the needles, head first, in the axes of orks, brought the needles to length, "sighted" their points ing them all in line, and hence parallel with the rod. Final- set the needles to the shaft centers, etc., keeping them ed fair, and, without difficulty or inaccuracy, laid out my r points, etc., on the sketch. It was a good example of "fudging," which is an act not always excusable, but sometimes the only thing permissible.

I beg to say that the only difficulty I have ever had with the metric system is one that has no more reason for being connected with that standard than with any other—the abominable folding rule. I have one with lateral springs which hold it nearly straight when new, but it will get "wackly" like others that preceded it. **Robert Grimshaw.**

Dresden, Germany.

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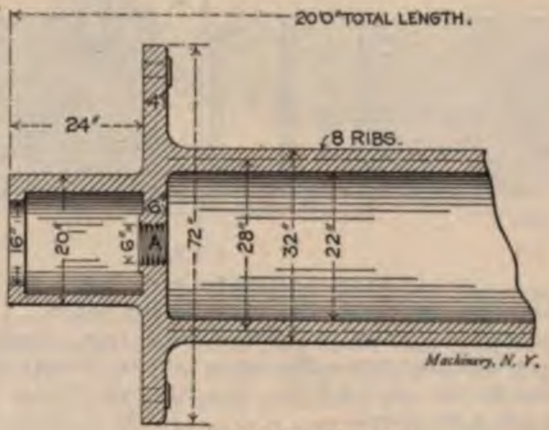
## A DIFFICULT THREADING JOB.

*Editor* Machinery:

In the shop where I work, a heavy business is done in the manufacture of rolls and rolling mill machinery, besides hydraulic machinery and considerable small work. We have an order for a very large and heavy lathe for turning granite columns which will be completed about May, 1900. The dimensions of the lathe are as follows: Swing 6' 6", center distance 60', total length of bed 86', with a width of 11'. The bed is made in ten sections, five on a side arranged in pairs. Six of the sections are 21' 6" long and four are 10' 6" long. The latter sections support the heads. A chuck is provided for each head and the headstock is 10' 6" long, quadruple geared, while the tail stock is of the same length, but without gearing. Four carriages are provided with compound rests and each carry two tools, one on each side of the column being turned. The feed screws are 86' long with 60' of square thread. The screws have a reverse feed clutch. The total weight of the lathe when completed will be about 150 tons.



Difficult Internal Threading Job.

The shop is a small one and is not very well equipped for such heavy work, as you will see from the way I had to manage in the following described threading job.

We had to make an accumulator barrel 20' long and thread the end as indicated in the sketch. The hole was six inches in diameter and was to be threaded, nine threads to the inch. We could do all of the machine work very well until we came to the threading part and then we were "stuck" for a time. To tap out the hole would have been an ugly job and the tap would have cost a considerable sum, with the probabilities of never being used again. We could also have done it in a lathe, but only at heavy expense for rests or we could have put on a flange, but the designer would not allow such a construction. I finally managed to do the job at an expense of only about $4 and took about three hours to do it, which bears out the saying that a job often looks the hardest before you tackle it.

I threaded the hole on a Niles boring machine with a belt feed, but had to remove the tool at the end of every cut. I succeeded in cutting a good thread, however, in about three hours, as stated, which, considering the difficulties of the job, was not a bad showing. **J. W. Bourn.**

Philadelphia, Pa.

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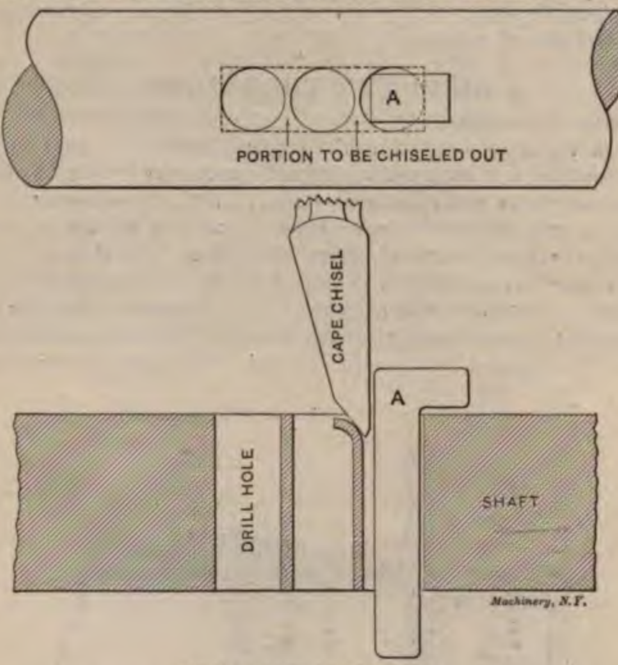
## SCHEME FOR CUTTING OUT KEY-WAYS.

*Editor* Machinery:

I used to take Machinery and still have the issues for the three years during which I received it. They furnish me with studying matter enough to keep me quite busy and have been a great help in times past. The column "What Mechanics Think" has always interested me and I will contribute a kink that I have found very useful in my experience. It may help some beginner and also be of benefit to some of the older heads. I think that it is original with me and has been found to be a great labor saver.

It is very difficult to cut the web out between the holes drilled for a slot in a large shaft or even in a small one, where the slot is to be quite narrow; but, by the use of the scheme illustrated in the accompanying sketch, the difficulties vanish. I put a square piece A through one of the holes to form a backing for the cape chisel and then a chip can be cut clear through the wall between the two adjacent holes. It is then easy to clear out the sides with a flat chisel. M. E. BUSHNELL.



An Aid to Cutting Key-ways.

St. Louis, Mo.

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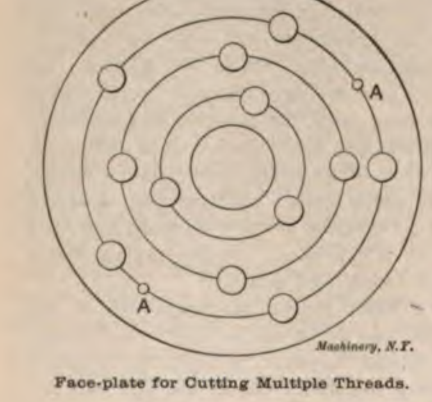
## TO CUT MULTIPLE THREADS.

*Editor* MACHINERY:

Some time ago a person came to see me and asked if I would cut him some four-threaded screws. He brought me a sample of some that other parties had made for him, but said that he could not use them on account of their being unevenly divided. I devised a method of cutting multiple-threaded screws of two, three, four, five, etc., threads which is very simple and mechanically perfect. I made a plain circular plate to bolt on the face-plate of the lathe and located and held it in exact position with two small dowel-pins, AA. Then a number of circles were scored in same. The circle nearest the center was divided into three parts, the next one into four parts which answers for two divisions as well, the next one into five parts, etc. Holes were drilled in the circles large enough in diameter to hold pins for driving the carrier. To use the plate for cutting multiple threads the carrier is moved from one pin to another until each thread is cut. The plate mentioned is kept specially for multiple thread cutting and can be bolted on by set bolts through the back of the face plate. With this rig there is no counting of teeth, and no wishing you had a wheel or certain number of teeth so that you could divide them evenly. I have been using this method for not less than ten years and have never seen it published in any paper and never came across any machinist who had seen it. JAMES H. GOMERSALL.



Face-plate for Cutting Multiple Threads.

Germantown, Pa.

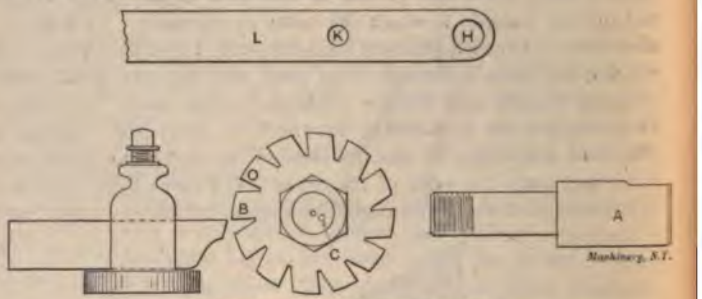
## SIMPLE LATHE RIG FOR BACKING OFF MILLING CUTTERS.

*Editor* MACHINERY:

Readers of MACHINERY will remember an article on backing off milling cutters some time ago in Shop Kinks. Now, while that method may have been all right for a few mills, I think the way I am about to describe is better.

The outfit consists of an eccentric arbor and a lever two and one-half feet long. The arbor should be case hardened at the ends and should have a fine thread so that the nut will clamp the mill tight with the least amount of exertion on the part of the man at the end of the wrench. When the eccentric centers are placed in the lathe centers and the arbor turned around to the position shown, a flat must be ground on the large end for the set screw in order that the dog can be put on the way it was before. The hole H of the lever L should make a snug fit on the head stock center and be bolted to the face plate at K in such a way that when the front edge of tooth O is 1/16" from the cutting edge of the tool, the lever will hit the lathe bed. A piece of belt-lacing tied around the lever at that point prevents bruising the bed.

In backing off tooth B, loosen the nut, hold the lever against the lathe bed, run the tool between B and O, bring O against the tool and tighten the nut. When the nut is tightened it will lift the edge of O about 1/16" from the tool. Move the lever up and down, feeding the tool in with the right hand. Repeat this operation for each tooth.



Rig for Backing Off Milling Cutters.

If greater accuracy is desired in the distance the front edge of O is from the tool, make radial lines on the side of the mill against the shoulder of the arbor, from the front edge of the teeth with a scriber. When the lever is against the lathe bed and O is 1/16" from the tool make a mark on the arbor opposite one of these radial lines. After the tooth is backed off, move the mill around and tighten the nut, seeing that the next radial line coincides with the mark. It is well to cover the mill with a solution of copper sulphate (blue vitriol) so as to be able to see when the cut comes to the front edge. Everything about the lathe should be as rigid as possible to insure good work.

I have backed off hundreds of dollars worth of milling cutters in this way and found it very satisfactory. "WIN."

* * *

## INSERTED CUTTER TOOLS.

*Editor* MACHINERY:

In your January issue, "Bell Crank" asks some questions concerning inserted cutter tools: What fault is to be found with them? Why not more used?

A small shop, near Boston, doing general machine work and employing about thirty hands, was entirely refitted about a year ago. A portion of the equipment of small tools consisted of a complete set of inserted cutter lathe tools. Three or four sizes of the ordinary and offset tools were provided; also several sizes of boring, thread and cutting-off tools. They were kept in the tool room and with a solid wrench of proper size were issued only on check. It was the intention to use these tools wherever possible and, consequently, few forged tools of the ordinary patterns were furnished. The test has been a more than ordinarily severe one, as the shop is one in which many of the hands do all the work on a particular job, changing from one machine to another as occasion requires. For a portion of the time, the shop has also been running nights with a separate shift of men, all tools being supposed to be returned to the tool room before closing time. There being a separate man in charge of the tool room for each gang, it has not been an easy matter to keep the run of the tools, nor to fix responsibility for damage. For these reasons a man seldom has the same tool twice in succession and, therefore, takes less care of it than if he used it continuously. At the present time those of the above tools still in the possession of the shop, a number having mysteriously disappeared, are in about as good condition as the day they arrived. That they are not in just as good condition is due to wear and tear and the inability of man to create a "fool-proof article." Some of the lathe tools have the set screws somewhat bent, with the heads a little out of shape and, in one or two cases, the nibs under the cutters broken or ground off. These things affect but little the value of the tools. The cutting-off and thread tools are as good as ever. So much for the holders. Concerning the cutters, the expense for self-hardening steel has been greater than it ordinarily would be because of the necessity of re-grinding the cutters each time the tool changes hands or else, because of each man having his own set of cutters. With the thread and cutting-off tools such has not been the case, but trouble has been caused by the "blockhead" who used up a cutting-off tool blade, trying to use it upside down in the holder. He explained the trouble by saying: "T'ain't no good; ain't got no clearance." The same hand decided that the thread tool angles were not correct and succeeded in ruining several cutters before he was discovered.

Regarding the comparative cost of forged and inserted cutter tools, I cannot give the actual figures; but, as the inserted cutter tools supplant a much larger number of ordinary tools, the first cost must be less. The time occupied in tool dressing must more than offset the cost of self-hardening steel, while the grinding time will be considered as equal since, if the plain inserted cutter tools take more grinding than an equal number of similar forged tools, the cutting off and thread tools certainly take less.

As "Bell Crank" says, the inserted cutter tool is not as stiff as the forged one, nor can it be used so well in corners, nor substituted for broad faced or side tools. The thread tools, as I know them, can not be used as close to a corner as the forged ones. Outside of this, I see no objections that can be raised by the workman. It may be well to add that now, near the close of the year's use, we have a very complete set of forged tools which have been worked in little by little for special jobs, and are now used together with the cutter tools, both kinds being apparently equally popular. I believe that as the cutter tools become better known, they will gradually supplant the older ones; for a man likes best the tools he is used to and most of us were "brought up on forged tools." However, the apprentice of to-day, by using the two side by side, will like one as well as the other and, in future, will be content with which ever one is given him.

W. G. R.

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## ABOUT LATHE AND PLANER TOOL HOLDERS.

*Editor* MACHINERY:

In reply to Bell Crank, in the January issue of MACHINERY, would say that I introduced the Armstrong tool holder in two places, both jobbing shops, and, in the first case, the initial tool was watched closely by the proprietor, as I had recommended it very highly. Two pieces of tool steel 4" × 1" × 72" were the test pieces. These were made from the same billet and both were annealed at the same time. One of these pieces was put on a 32" planer with the Armstrong tool and the other was put on a 60" planer with a genuine Mushet tool. The man running the 60" machine was a "hustler" and prided himself on what he could do with this tool, which he kept for special occasions. Both planers ran at the same speed and the clamping of the pieces on the planer was the same. The total time required on the 60" machine was 8 hours and on the 32" machine 5 hours. This result spoke volumes for the tool holder and its steel which, in my estimation, is the "finest of the fine." Still, even after this demonstration I have been informed that, since I left, they do not use tool holders any longer. The steel required is high priced and a little of it costs a great deal so that, each time you put in a requisition for steel, you are confronted with the question: "Is that steel all gone?" This, in itself, is enough to make a man wish that he had not said anything about tool holders and to cause him to neglect them and let them die out slowly.

It is one of the hardest tasks in the world to convince some people of what is to their own interest. They only seem to see the cost of tools or improvements and ignore the fact that they are deriving any benefits; or, if they see any benefit, they attribute it to some other cause, such as their fine management of finances, but never to the improvements made in the shop. They consider that they could have got along as well without these, but wanted to humor the man in charge.

Now as to the difficulties with the tool holders. I find that, when a tool breaks, it does so just inside the holder and, after a time, the holder is rounded in front as shown in the sketch at A, Fig. 1. The holder does not then support the cutter as it should and each successive break moves the rounded part further back. Finally it gets so far back that tightening the screw breaks the cutter. It is rather a tedious job to straighten out the bearing and, even then, it does not give satisfaction for, when the cutter is inserted and screwed down, there is a small space between it and the holder, into which the cuttings find their way. The first thing you find out, in such a case, is that your tool is choked.

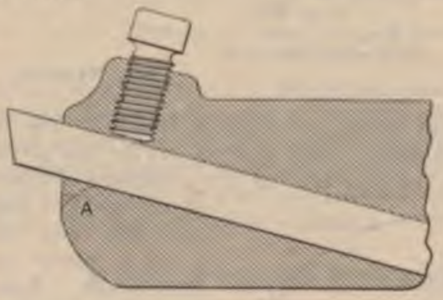
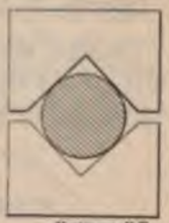


Fig. 1.



Machinery, N.Y.

Fig. 2.

Another source of trouble is the set screw which is generally too small and soon gets upset on the end. You cannot remove it without annealing and drilling it out; but, in spite of these drawbacks, they are a great improvement over the forged tool and, in the hands of good men, they give very little trouble. My foregoing remarks were in regard to men who never think that a screw might work easier if they put a drop of oil on it once a week, who let the cutter project an inch or more from the holder, grind off all the rake and crowd the metal off instead of cutting it, or who let the holder project two or three inches further from the tool-post than necessary. There are more of this class of men than of the other, by a large majority, and it is because of these men and proprietors who will not be convinced, that the forged tool hangs on so long.

If you are given two ordinary tool holders, a straight and an offset cutting-off tool holder, one 1½" round boring bar holder, one 1" round boring bar holder with a bar 18" long, about three round boring tools ½" and ¾" diameter 12" long, with a holder for same as shown in Fig. 2 and steel for the holders, you need not fear very many jobs that are done in a job shop on a 24" lathe. One hour a week will more than suffice on the part of the tool dresser as I should never bother him with cutting off the steel for the holder, but would do this at the emery wheel to avoid spoiling the steel; for, if the steel happens to be soft or not what it should be, the manufacturer could find no fault with me for misusing it, although I do not have much trouble from this source.

A. MERTES.

Emsworth, Pa.

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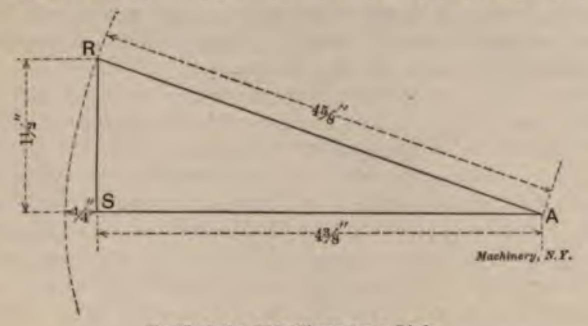
## METHOD OF FINDING HYPOTHENUSE OF RIGHT-ANGLED TRIANGLE FOR A GIVEN LIFT IN A MACHINE.

*Editor* MACHINERY:

I was interested in the article, "A Comedy of Errors," by W. H. S., in the January issue, especially in that part that concerns the 1¾" lift from the 1½" arm of the bell crank lever. I am afraid "Jones" could not get it with those wonderful proportional dividers, even if he had been fortunate enough to own a pair. I suppose the lift could be obtained by the "cut and try" method, but I herewith send sketch describing a ready means of finding the length required in this or any similar case. By inspection, we find two essentials; that is, the short arm of fixed length—1½" and the excess of length of hypothenuse over that of the altitude—¼". To find the radius that will describe an arc passing through R and pass beyond the angle S exactly ¼", we proceed as follows: We square the length of arm 1½" = 2¼", add to that the square of the distance marked ¼" = 1/16", divide that sum by the ¼", and divide the quotient by 2, which



To Find the Lift Given by a Link.

gives the radius required. By calling the arm C, and the ¼" distance D, the formula would be

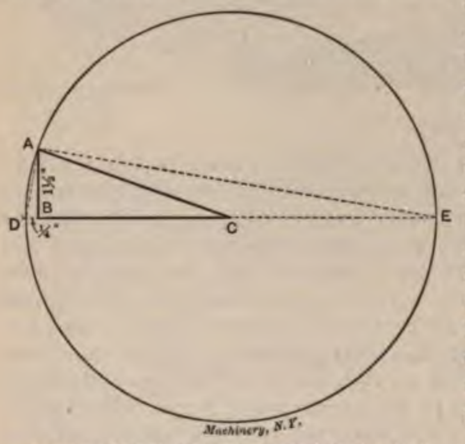
$$R = \frac{C^2 + D^2}{2D}$$

Oneonta, N. Y. WM. NEWTON.

[Another method for finding the required length of link is given in the following, which is not as simple as the one given by our correspondent, but of interest as it is a different solution of the problem and one that may be found useful in other ways. Consider the triangle ABC as being within a circle with the vertex C at the center and the right angle B at a distance of ¼" from the circumference. The side BC, being extended in each direction, forms a diameter of the circle or the line DE. Connect AE and AD and we have the triangle DAE, which is a right-angled triangle, since it is inscribed in a semi-circle with the diameter as one side. Therefore AB is a mean proportional between the segments DB and BE, being a perpendicular drawn from the right angle to the hypothenuse. Hence,

BE: 1½: 1½: ¼
¼ BE = 2¼
BE = 9 inches.

The diameter of the circle is then 9 + ¼ = 9¼ inches and AC, the length of the link, must be ½ of 9¼ or 4⅝ inches since it is a radius of the circle. The length of the distance BC is 4⅝ — ¼ = 4⅜ inches.—Editor.]



Another Method for Finding the Lift of a Link.

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## SOLUTIONS AND SUGGESTIONS TO THE PROBLEM IN THREAD CUTTING.

*Editor* MACHINERY:

Referring to the practical problem in thread cutting given in the January issue, I would say that with the gears arranged according to the sketch, the lathe will cut a thread having one inch pitch, which was the pitch required. By changing the reverse lever a thread of the same pitch would be cut, but it would be just the reverse of the other. The tumbler gears, being only intermediates, cannot change the ratio, but they simply reverse the direction of the thread cut. To obtain eight parallel threads it is only necessary to divide the 64 T gear into eight equal parts by marking every eighth tooth with chalk and also putting one mark on the 32 T between two teeth. Now cut one thread and then pull the belt until the mark on the 32 T gear corresponds with a mark on the 64 T gear. Drop the quadrant until the 32 T gear clears the 64 T gear and pull the belt around until the next mark on the 64 T gear corresponds with the mark on the 32 T gear when the gears can be brought into mesh with the marks corresponding for cutting the next thread. The operation can be repeated until all the threads in the circle are cut.

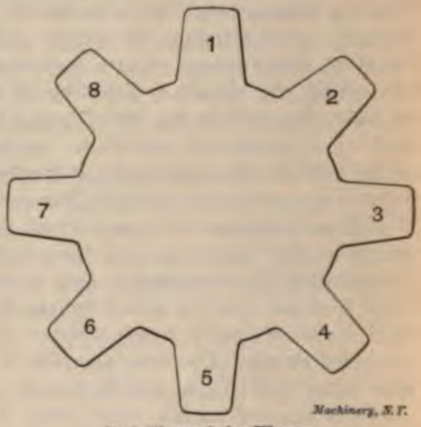
I think that Mr. Johnson must have made a mistake in his divisions and if he will examine the threaded pieces, he will undoubtedly find the lead on both the right and left screws the same, the only difference between the two being that one has eight threads and the other nine. H. BRESCH.

Covington, Ky.

*Editor* MACHINERY:

I will endeavor to throw some light on the difficulty of Mr. Edward O. Johnson, as mentioned in his letter in the January issue of MACHINERY. As I understand it, the worm to be cut was like that shown by the end view in the sketch, consisting of eight parallel threads. To cut such a worm, we will assume, for an example, that it is 10" long and will set the lathe carriage at a certain point and run 10", and cut No. 1 thread. Then, to cut No. 2 thread, unlock the split-nut and run the carriage back 10⅛" and again lock with the lead screw. When the thread is finished, run the carriage back 10⅜" and finish No. 3. This operation is to be continued until all the eight threads are cut.

On the lathe in question, it saves disconnecting the gearing as Mr. Johnson did. If he wished to make the divisions by disconnecting, he could have divided the large gear into eight parts and then mounted a pointer at some point and thus have made his divisions without the possibility of an error.



End View of the Worm.

Rockford, Ill. A. E. PHILLIPS.

*Editor* MACHINERY:

I note the diffifficulty of Mr. Edward O. Johnson, in his "Problem in Thread Cutting," in the January issue of MACHINERY, and as the samples are not within my reach for inspection, I advance a suggestion rather than a "correct solution," such as the writer asks for.

Let us first consider the principle relating to the gearing of this special instance and, if found correct for the right hand thread, surely it must be correct for the left hand thread as well. We find that the 37 T gear on the latter spindle corresponds to the 37 T gear on the reversing spindle. Therefore they are equal or 1 for 1. It matters not what the tumbler gears are, whether 10 teeth or 100 teeth, nor even 1 of each, as they are only for reversing motion. We further find that Mr. Johnson used a 64 T gear on the spindle which, in turn, drove the 32 T gear of his compound 32 T and 128 T gear which was mounted on the stud. From the combination we get the following:

$$\frac{64 \div 32}{128 \div 32} = 1 \div 8$$

and with the lead screw 8 threads to the inch, we have the lathe geared for 1 inch pitch. We can cut one thread at a time by using the same thread in the lead screw either by running the lathe backwards, catching the thread of said lead screw on even inches, or by stopping the lathe, throwing out the apron nut and measuring back.

Where Mr. Johnson failed, was in loosening his special gear and trusting to re-mesh his 64 T spindle gear, eight teeth in advance of his former mesh. This, Mr. Johnson seemed fortunate enough to accomplish in right hand threading, while he failed in the left hand threading. The error was in taking out the supposed slack in the train of gears for left hand cutting. Mr. Johnson lost a tooth which made him advance the gear only 7 teeth instead of 8 teeth, as he should have done. The 64 T gear being divided by 7 = 9 times (or threads) + 1 tooth extra in the spindle gear. This slight variation one would hardly notice in cutting threads by the slipping gear method.

Mr. Johnson, after finishing one thread, had measured ⅛"
to catch the other thread in the lead screw, I am of the
on that he would have had 8 threads on both the left and
hand threads. F. T. Miller.
ashington, D. C.

r Machinery:

article appeared in the January number of Machinery
led "A Practical Problem in Thread Cutting," on which I
offer one or two suggestions. In the first place, I don't see
Mr. Johnson found it necessary to disturb his gearing,
r the condition given, after once setting it. He has an 8-
lead screw on which to cut an octuple thread; all that
d be necessary, when changing from one thread to the next,
d be to throw out the split nut on the lead screw and move
carriage ahead or back one thread and drop in the nut
n. In my opinion the reason why he cut 9 left-hand
ds while only 8 right-hand, was owing to the tool and not
e lathe. The tool did not have clearance enough and hence
crowded back so that it turned slightly in the holder or
post. The result would be as shown in Fig. 1, in which 1,
d 3 represent three perfect teeth on a larger scale than the
ple to more clearly illustrate it. A and B represent the dis-
from a point in the finished thread to a corresponding
in the first cut in the next thread. In this case it would be
Now, after finishing thread No. 1, the tool is moved ahead
nd the cut started. When the thread is finished, it will be
d to have followed the dotted line and the tool will have
crowded back a distance equal to C. When the tool is
d ahead ⅛" for the next thread, instead of coming directly
e center of 3, it falls a distance equal to C nearer the side
rd thread 2 and, as a result, at the end of the eighth thread
s lost enough to cut another thread. This result is some-
out of the ordinary run, as it will generally be found to be
or less than 1 thread.

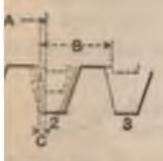


Fig. 1.

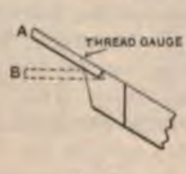


Fig. 2.

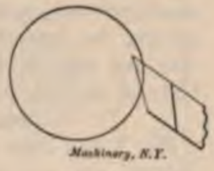


Fig. 3.

ell Crank," in the same issue of Machinery, wants to know
eason why inserted cutter lathe tools are not more ex-
vely used. In my experience I have found that prejudice
st them by the working men is the principal reason why
are not used. I have used them for several years and would
like to go back to forged tools again, as I find I can do
r and more work with the inserted cutter. While on the
cts of threads and inserted cutters, I will point out one
into which nearly all machinists fall in grinding a tool to
V thread with inserted cutters. They will try their thread
e on the tool as at A, Fig. 2. Now, by referring to Fig. 3,
ll be seen that the line passing through the center of the
is not on a line with the top of tool and, by trying your
d gauge on the tool, as at B in Fig. 2, you will find that
ool is not ground at a small enough angle. The thread
ith it will, therefore, cause the thread in the nut to bear only
e point. B. L.

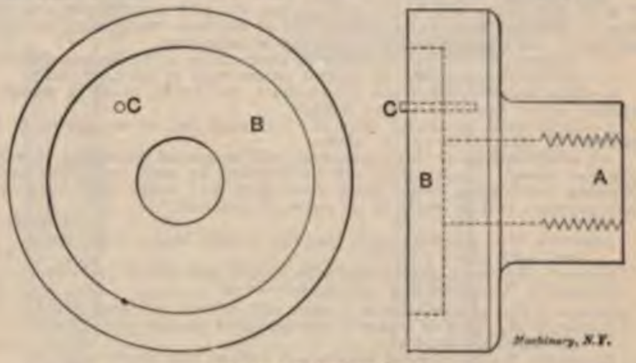
* * *

## A CHUCK FOR BORING GEARS.

r Machinery:

was through seeing a similar device described in Machin-
hat I made the device illustrated herewith for boring small
During the past year I bored over five hundred small
and will have at least three hundred to bore during the
ng year. As the work had nearly ruined the chuck jaws, I
d up this device to save the chucks and also to save time
ucking the work. A female shaft coupling was taken and
and threaded for the lathe spindle nose as shown at A
as then screwed on the spindle and counterbored at B to a
hat would let the gears slip in nicely. A hole was drilled
apped in the flange at C and a pin screwed into it to drive
ears by the spokes. C. A. F.
ndon, Man.

[From personal experience we can state that the above simple scheme is one well worth adopting where a number of pieces, similar to the gears mentioned, are to be bored accurately. The parts, of course, have to be all of the same external diameter. This scheme is in reality only a modification of the step-chuck that is much used by watchmakers and repairers. Instead of having only one recess bored on the face of the chuck, a number are bored which give it the step appearance, hence the name. To provide for all the sizes required, duplicate chucks are provided which have the same number of steps but with the sizes intermediate between those of the preceding chuck. By a judicious arrangement, in a set of chucks nearly every size of watch wheel met, can be handled.—Editor.]



Chuck for Boring Gears.

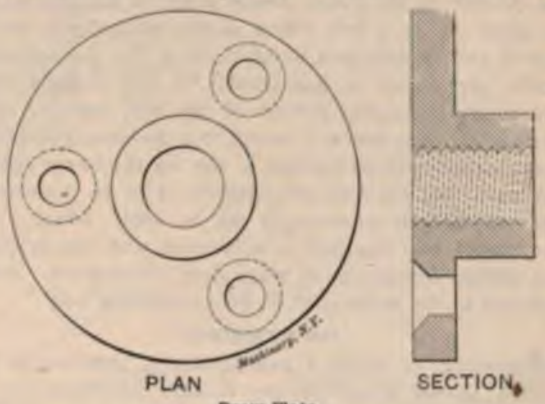
* * *

## A DRAW-PLATE FOR PATTERNS.

*Editor* Machinery:

The question by J. T. B. in regard to draw-plates and your answer to same on page 159 of the January issue of Machinery reminds me of some I made while in the pattern shop and which were more convenient than any others I have ever seen or know of. These draw-plates are reproduced in the accompanying sketch. Previous to getting them, we had been using some similar to those shown in Fig. 1 of your description, but we found those cast from patterns shown in the sketch much more satisfactory. The patterns were made in two sizes about 2½" and 1⅜" diameter with lugs on the bottom ⅞" and ⅝" diameter. The lugs were also made of different lengths to accommodate thick or thin patterns. These draw plates were cast in iron or brass as convenient. They are to be applied by boring two concentric holes. S. M. Preston.

Pinon, Col.



Draw-Plate.

* * *

### WELDING STEEL.

Practical steel workers know that with some kinds of steel it is very difficult to make a solid weld, says a writer in "Sparks." From my own experience I recommend, when practicable, a "V" scarf. The end of one of the pieces to be welded should be split; then point the other piece and put them together before placing them in the fire for heating to weld. Heat the steel slowly to an even red, then apply borax, and bring the heat up slowly to nearly the welding heat; then take some soft iron filings and sprinkle them over the steel where it is to be welded; put on more borax if necessary and bring the steel up to the welding heat. By the use of iron filings a stronger and sounder weld can be obtained than by the use of borax alone.

## SHOP KINKS.

### A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

**Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.**

### SPECIAL OFFER FOR SHOP KINKS.

To encourage our readers to send more descriptions and photographs of good shop kinks and handy devices, we will give contributors the privilege of selecting from the appended list of desirable machinists' tools, according to the value of the different devices submitted.

To compete, it will be necessary to observe the following conditions:

1.—All descriptions shall be written on one side of the paper only.

2.—The necessary sketches to illustrate the device shall be made on separate sheets from the written matter.

3.—Tools shall be chosen from the following list, as no option in the selection of other tools can be given.

All contributions to this department will be graded, according to value, into four classes. Contributors will be informed by mail during the month following publication, from which class they may make their selections. Cash payment will be made in all cases, if preferred.

| | | List Price. |
|---|---|---|
| 1. | Starrett's No. 9 combination square, 12-inch blade, with center head and bevel protractor | $4.00 |
| | Sawyer's No. 100 surface gauge with 12-inch and 18-inch spindles | 3.50 |
| | Slocomb's No. 17 outside micrometer caliper | 3.50 |
| 2. | Sawyer's No. 39 combination square with 12-inch hardened blade | 2.50 |
| | Starrett's No. 56 tool maker's case-hardened surface guage, without auxiliary guides | 2.50 |
| | Slocomb's No. 12 internal micrometer caliper with depth gage attachment | 2.50 |
| | Starrett's No. 11 combination square, 12-inch blade, with center head | 2.00 |
| 3 | Slocomb's No. 11 internal micrometer caliper | 1.75 |
| | Starrett's No. 13 4-inch square, with two blades | 1.65 |
| | Starrett's No. 15 universal bevel | 1.50 |
| | Sawyer's No. 18 spring tempered rule, 12-inch long | 1.25 |
| 4. | Starrett's No. 40 screw pitch guage | 1.00 |
| | Sawyer's No. 19 flexible rule, 9 inches long | .90 |
| | Starrett's No. 79 outside spring caliper, 4 inches | .75 |
| | Starrett's No. 73 inside spring caliper, 4 inches | .75 |
| | Starrett's No. 83 spring dividers, 4 inches | .75 |

### SUCCESSFUL BELT DRIVE.

In Fig. 1, on page 221, is a diagram of a belt drive in the new shops of the F. B. Shuster Co., New Haven, Conn. It shows the means adopted for transmitting power from the jack-shaft to two main lines of shafting, A and B, one of which drives the upper floor of the shop and the other the first floor. These lines of shafting are at the center of the building, and as the engine house stands near one side of the shop, the jack-shaft is placed in the shop , near that side, that the engine can be belted directly to it. From thence power is transmitted to the upper shaft A, by a belt which passes vertically to two idler pulleys C and D, and then horizontally to A. As vertical belts generally give more or less trouble, it was thought that the weight of the horizontal portion of this belt, together with the pressure of the idler pulley I, would, in a measure, counteract the tendency of the vertical portion to slip on the lower pulley. It would seem that such an arrangement is to be preferred to a simple vertical belt wherever it can be used. Idlers I and D are so placed that the belt is in contact with the driving and driven pulleys for an arc of more than 180 degrees. Power is transmitted to the lower shaft B by a horizontal belt.

### JIG BUSHING.

The bushing, of which a half section is sketched in Fig. 2, was seen at the shops of the Bullard Machine Tool Co., Bridgeport, Conn., and is made an easy fit in the body of the jig so that it can be removed and another substituted of different diameter. The upper part of the bushing is larger than the main portion, and is cupped out for convenience in oiling. An oil-hole O conducts the oil to the cutting edge of the drill, and the pin P keeps the bushing from turning. If a bushing of this character should trouble by being lifted out of place through the action of the chips from the drill, it can easily be arranged to lock securely in position.

### TWO PROVIDENCE KINKS.

"Retsel" sends a description of two kinks that he saw at the Builders' Iron Foundry shops, Providence, R. I., some time ago and which he thinks well worthy of attention. The first is illustrated in Fig. 3, and is a rig designed to accomplish on the drill-press the work that is generally done with a set of chucking tools in the lathe. He writes: "The result is not as good as attained where the work revolves and chucking tools are employed, but it oftentimes answers the purpose. One end of the piece in which a hole is to be finished is indicated at F. This piece is held in a jig by the clamp G, and it has a hole cored through it somewhat smaller than the finished size. Just above and in line with F is a long cast-iron bushing, which is a part of the jig, and has a hole about ¼ inch larger than the size of the finished hole in F. The tool used is an ordinary end mill, D, which is held in a long extension collet C, of such a diameter that it is a free running fit in bushing E. This collet is suspended loosely by a semi-universal joint B, in the way that a floating reamer is usually supported, and the whole rig is clamped to the drill-press spindle by the split hub A. Since the mill is not held rigidly by the spindle, it is guided in a straight line entirely by the collet C, which fits in bushing E. This keeps it accurately in line, and one cut through an ordinarily smooth, cored hole leaves the hole straight enough for hand reaming. The advantage of an end mill over a drill for this work is that it cuts on the end only, and not on the side, and there is less tendency to " run" than in the case of the drill.

"The next figure shows how they mill grinder boxes and caps for some of the emery grinders that they manufacture. The caps and boxes are milled instead of bored before reaming and they are tongued and grooved to keep them in place. The set of three cutters, A, B and C, shown in outline in Fig. 4, serve for both the lower and upper part of the boxes. The sketch shows them as they appear when at work upon the bottom half of a box, D.

"Fig. 5 comes pretty near killing two birds with one stone. It represents a partial side view of one of these grinders in process of having the boxes milled. It was found that the grinder arms were not rigid enough to stand the heavy strain of the broad milling cut without vibration, and some one suggested casting the caps for the bearings of the grinder between the two arms, as indicated by the dotted lines at A and B, Fig. 5. They would not only stiffen the casting, but could also be milled while milling the lower half of the boxes. This was tried with success, and after the milling, the two caps were separated from the body of the casting by slitting saws."

### TWO FROM PENNSYLVANIA.

Fig. 6 is a little sketch sent by Mr. Freeman Knight, Philadelphia, who says it is the proper way to turn up the centers for a large lathe before hardening and grinding. By finishing in this way much time is saved when regrinding the centers from time to time, and nothing is sacrificed in strength.

S. V. E., Lemoyne, Pa., writes: "This being the revival season I send you a sketch of a worn-out drill collet, and show how it was revived to do better and more work than ever before. In the sketch (Fig. 7) A represents the body of the collet, B the mushet steel cutter ⅜ inch square and of a length suitable for the work to be done. D is a piece of ⅝" round cold-rolled steel to fill the space between the wedge C and the cutter B. The operation of this revived tool is very plain. Insert the piece D, then the cutter B, then the wedge C, which is driven in the drift hole of the collet, and you have a tool the utility of which is beyond question. The one that came to my notice was a Morse No. 2 socket with a No. 3 shank."

### LATHE MAKING IN VERMONT.

Mr. J. R. Rand, Brattleboro, Vt., has a fixture for holding lathe legs, when facing their tops on the planer, which is illustrated in Fig. 8. The fixture is made of neatly planed and fitted square timbers. There are two long timbers, extending across the planer table, one of which is indicated at A, and four cross pieces, indicated by B, B, etc. Suitable clamps are provided for holding the legs in place and the legs are so located that one cut with a planer tool will face off both legs at once. It is not necessary to take a finishing cut because the pressure on the tool is about equal on each side and a surface is obtained true enough for all practical purposes.

### TAPER REAMER.

In Fig. 9 is a two-bladed taper reamer used by the C. W. Hunt Co., Staten Island, N. Y. It has a cast-iron body with a slot in which a flat piece of steel is inserted for the cutting edges, as indicated. The steel is held in place by the keys W, W, which fit in notches in each end of the blade. While a double-bladed reamer will not give an absolutely true hole, it answers for many purposes. In Fig. 10 is the arbor employed for turning and grinding the steel blade. The arbor A is slotted to receive the blade and one side, C, of the arbor can be removed when placing the blade in position. The notches in the ends of the blade fit over the blocks D, D, which are pinned to A, and thus the blade is correctly located and is held rigidly in place when C is clamped down upon it. The blade is turned to

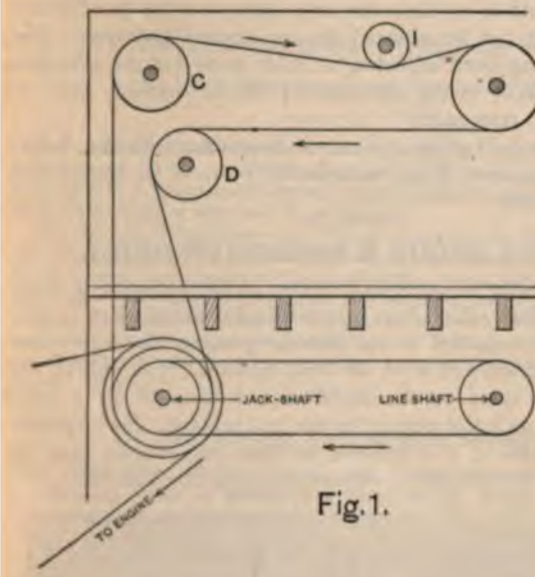


Fig. 1.

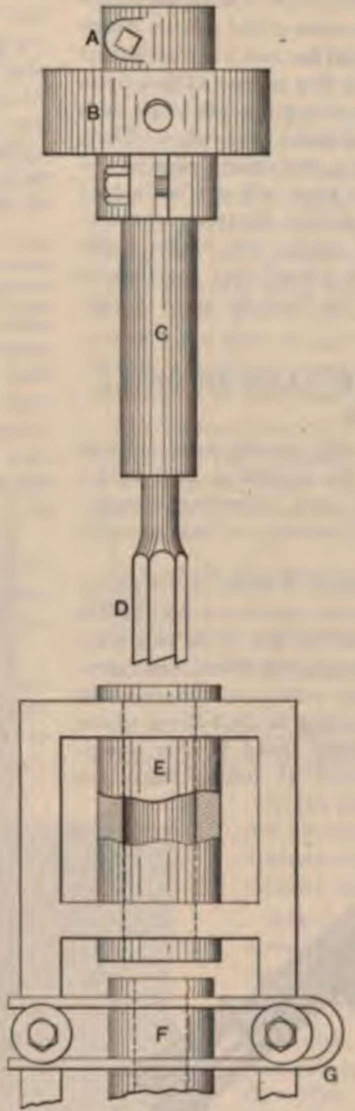


Fig. 3.

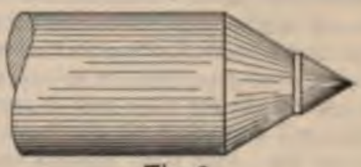


Fig. 6.

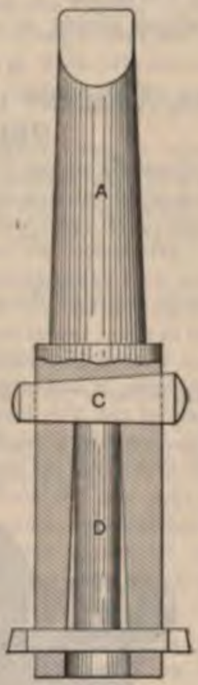


Fig. 7.

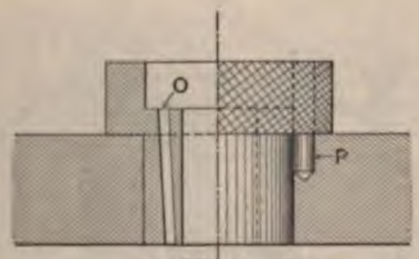


Fig. 2.

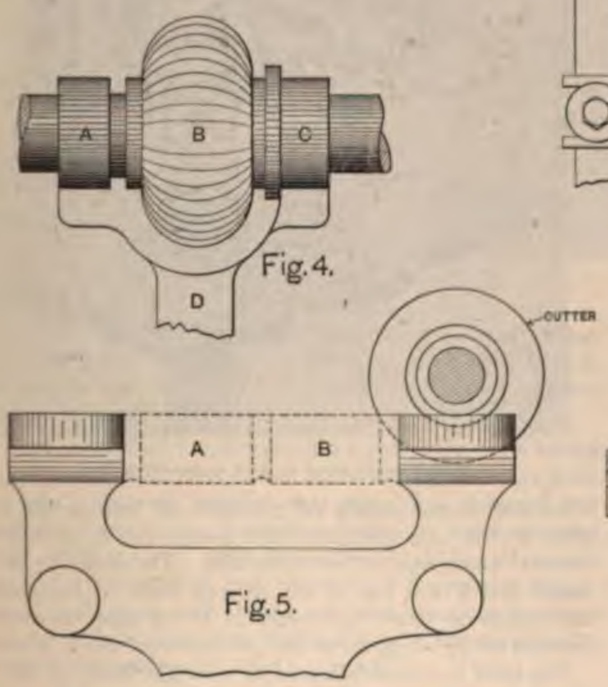


Fig. 4.

Fig. 5.

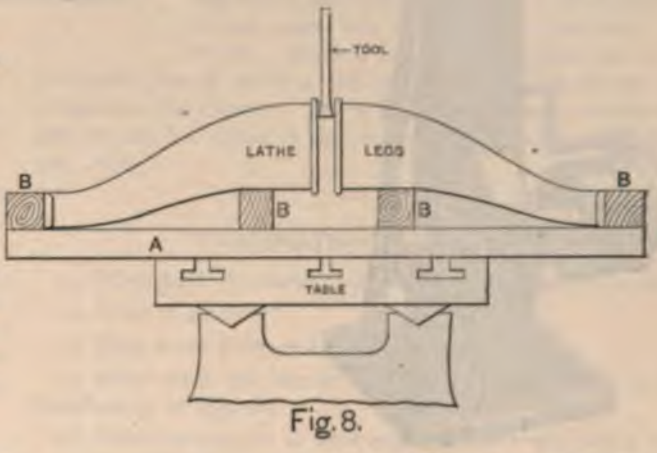


Fig. 8.

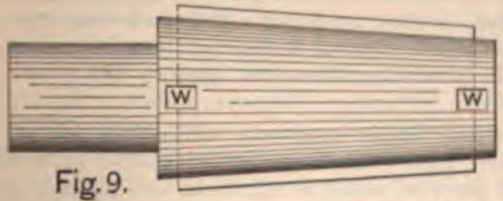


Fig. 9.

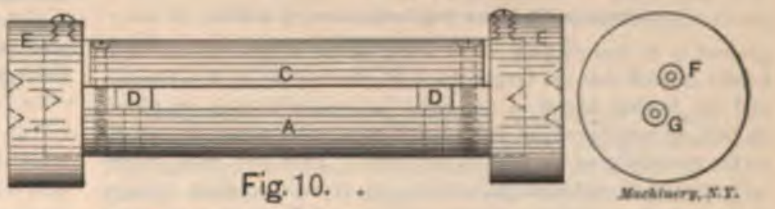


Fig. 10.

*Machinery, N.Y.*

A PAGE OF SHOP KINKS.

**Fig. 1. A Machine Shop Belt Drive. Fig. 2. Jig Bushing, with Oil Channel. Fig. 3. Drill Press Rig for Rough Work. The Cutter is guided by a long Bushing Figs. 4 and 5. Milling the Boxes and Caps for Grinder Bearings. Fig. 6. Center for Large Lathe. Fig. 7. Drill Collet converted into a Boring Tool. Fig. 8 Facing Planer Legs. Fig. 9. Taper Reamer. Fig. 10. Rig for Turning and Backing Off the Reamer Blade.**

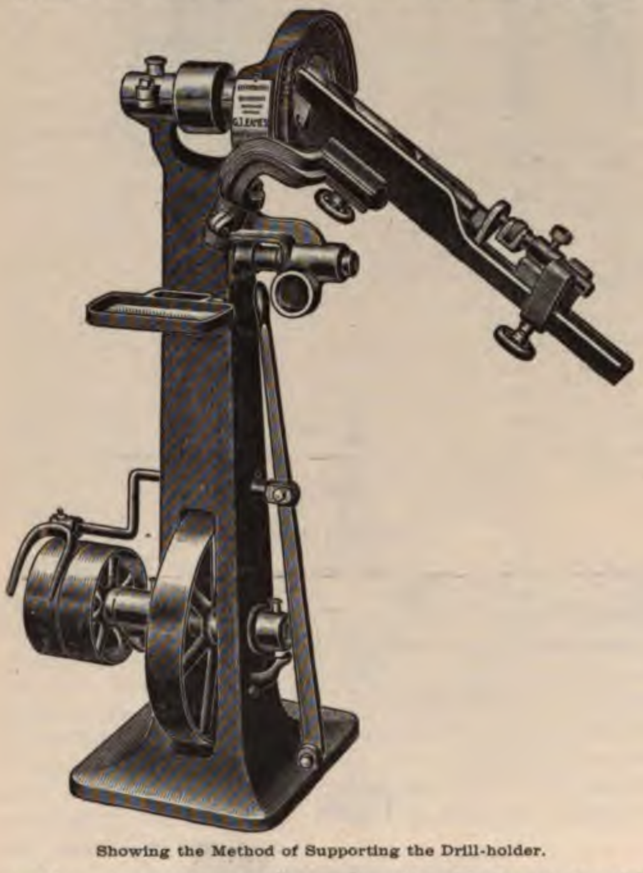
the right diameter and taper with the arbor upon lathe centers, and is then removed and hardened, after which it is replaced and the end pieces E, E, are fastened to the ends of the arbor. These pieces have offset centers, as shown in the end view at F and G, and by grinding the blade with the arbor supported first upon one pair of centers, the emery wheel will grind one edge with the necessary clearance, but will not touch the other edge. Then, by shifting to the other pair of centers, the second edge of the blade will be backed-off, but the first edge will not be injured in any way. One arbor answers for several diameters of reamers, and if it does not support the larger size blades stiffly enough, end pieces, like E, E, can be placed over the ends of the arbor, and by closing up against the blade be made to support it.

* * *

## AN IMPROVEMENT IN THE YANKEE DRILL GRINDER.

The manufacturers of the Yankee drill grinder have recently made an important improvement in the oscillating drill holder which entirely does away with gage jaws, calipering arrangements and other devices for correctly locating the axis of oscillation for the drill being ground.

Instead of placing the axis of oscillation in front of the grinding wheel as in other types, the journal on which the drill holder turns is now located beneath the wheel so that if its axis were extended upwards, it would pass through the wheel and intersect the apex of the V-holder slightly outside of the grinding surface. Consequently, a small drill resting in the bottom of the V-holder is held with its point slightly ahead of this imaginary axial line, and the cone on which its cutting edges are ground is of limited size. The angle of the V-sides to the drill holder is such that the larger the drill, the further up it is thrown and the further ahead of the axial line referred to is its point, so that its cutting edges are ground to a cone whose size is directly proportional to that of the drill. Thus any drill, either large or small, automatically takes the correct position relative to the grinding surface and the axial line of the holder, to grind the proper cutting edge. The necessary adjustment required on this machine for grinding any drill within its capacity is, therefore, only one when the clearance is unchanged, and that is the setting of the tail-stock to suit the length of the drill, which adjustment is obviously indispensable.



Showing the Method of Supporting the Drill-holder.

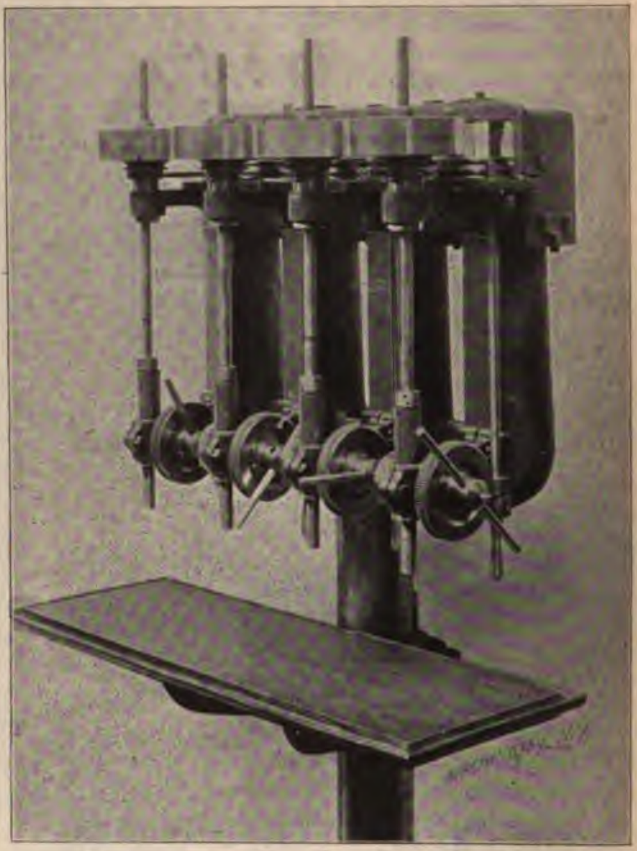
To change the clearance of the drills ground, the drill holder is made with its under surface curved and fitted to a seat of corresponding shape. A hand-wheel and screw, shown beneath the holder, hold it to the seat. By loosening the hand-wheel the drill-holder can be adjusted for any desired clearance. The clearance having been adjusted, it holds good for the grinding of any sized drill within the capacity of the machine (⅛" to 2¼"), without resetting.

The Yankee drill grinder is now manufactured by the Fuller Mfg. C., Kalamazoo, Mich., successors to the G. T. Eames Co. of the same place.

* * *

## A FOUR-SPINDLE SENSITIVE DRILL.

The four-spindle sensitive drill shown in the half-tone is made with sliding heads which have a vertical adjustment of 12". The countershaft is attached to the base to prevent the belt vibration disturbing the action of the drill spindles. The pull of the belt does not come on the spindles, but is taken by a quill having a steel rack and pinion for the feed motion. Each spindle has an independent stop-motion, so that any spindle may be thrown in or out of action without stopping the machine.



Automatic Feed Applied to Sensitive Drill.

Adjustable stop-collars are provided for limiting the depth of holes drilled. An automatic feed motion can be provided when desired, which has an automatic stop. The stop can be so adjusted that it will trip at any desired depth of hole and allow the spindle to return automatically to its upper position. The spindles are ⅞" in diameter and are bored for No. 1 Morse taper.

The table is counterbalanced by a weight inside of the column and has a vertical movement of 32". The spindles have a vertical travel of 4", so that the extreme distance between the spindles and table is 36". This sensitive drill is manufactured by the George Burnham Co., Worcester, Mass.

* * *

The 10-inch Brown segmental wire-wound gun is finished after nearly three years work. It is expected to be the most powerful gun ever made, as the initial velocity of a 575-pound projectile fired from it, is calculated to reach a velocity of 3000 feet per second. The gun contains a large number of segments held together by over seventy-five miles of square wire wound so that the segments are under heavy compression. The advantages claimed for the built-up form are that for a given caliber, the gun can be built much cheaper and lighter than by any other process.

# LESSON FOR MACHINISTS.

BY

THE UNITED CORRESPONDENCE SCHOOLS.

154, 156, 158 FIFTH AVENUE, NEW YORK.

These lessons are not intended to enter too deeply into the subjects treated, and mathematics will be simplified and omitted whenever possible. They will take up such points as machinists and others frequently meet in their work and with which many of them have found difficulty

The readers of MACHINERY are invited to answer the questions and solve the examples in these examinations and to send their replies and solutions to The United Correspondence Schools, 156 Fifth Avenue, New York. Their work will be carefully examined, corrected, and returned, just as if the senders were regular students of the Schools. The Schools will also be pleased to answer any questions concerning the following lesson. Write your name and address on all matter sent to the Schools, in order to insure the prompt return of the work.

## THE WORM AND WORM WHEEL.

**The Pitch Lines—Pitch of Worm and Wheel—Properties of Teeth and Threads—Sizes of Blanks—The Helix—Proper Angle for Cutting the Teeth of Worm Wheels.**

Knowing the method of calculating the diameter of a worm wheel, as well as the dimensions of the teeth, it becomes an easy matter to ascertain the exact size of the blank from which the worm wheel is to be made.

Since the threads of the worm are at an angle and each tooth of the wheel is in contact with a thread of the worm throughout one entire revolution of the latter, it is evident that in order to obtain contact along the whole length, the teeth on the wheel, instead of running straight across parallel to the axis about which the wheel revolves, like in a spur gear, must slope over at an angle which depends upon the pitch of the threads and the diameter of the worm.

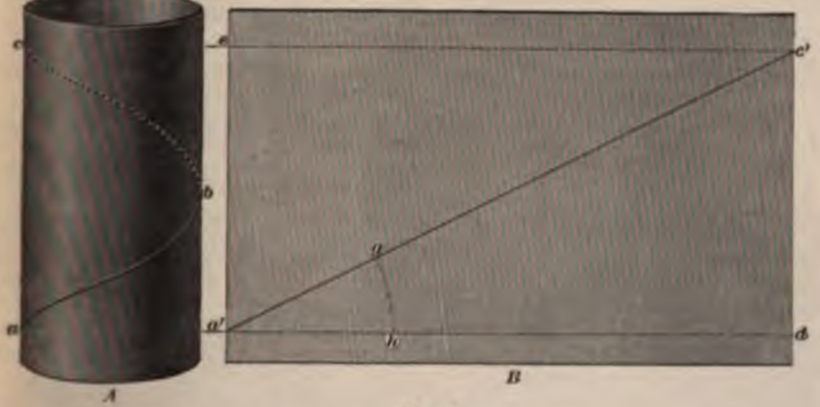


FIG. 2.

The curve formed by the threads of a worm is the same as the curve formed by the threads of any screw having the same pitch as the worm. This will become clear when it is observed that when cutting a screw or a worm in a lathe, the screw revolves uniformly while the tool with which the thread is cut moves uniformly in a straight line, and, therefore, if the relative velocities remain unchanged each thread will have precisely the same curve no matter how many threads may be cut. The curve of the thread cut in this manner is called a "helix."

A helix is, therefore, the curve traced by a point which moves around a cylinder and at the same time advances uniformly a certain distance along the length of the cylinder. The winding curve, or helix, thus produced is shown at A, Fig. 2. The curve $a b c$ makes one complete revolution around the cylinder while traversing the vertical distance $a c$. The distance $a c$ is the pitch of the helix and this distance is equal to the distance that a point on the pitch circle of the worm wheel moved by the worm when the latter makes one complete revolution.

Let us now investigate the method of finding the angle of the helix $abc$, since this is the angle which the teeth of a worm wheel must have if the diameter of the worm at the pitch line were equal to the diameter of the cylinder shown in Fig. 2, and the pitch of the thread were equal to $ac$, the pitch of the helix shown on the cylinder.

Let us first cut the cylinder vertically along the line $a c$ and then flatten it out, as shown at B, Fig. 2. We see that in this position the helix $a b c$, instead of being a curve, becomes a straight line $a' c'$, and that the distance $d c'$ is equal to the pitch of the helix or a c, and the distance a' d is equal to the circumference of the cylinder. This will always be the case, irrespective of the diameter of the cylinder, and of the pitch of the helix; therefore, to find the angle of any helix draw a line $a' d$, and on it lay off a distance equal to the circumference of the cylinder.

At the point $d$, erect a perpendicular $d c'$, and on this perpendicular lay off a distance equal to $a c$, the pitch of the helix. Then draw a straight line $a' c'$ and the angle $c' a' d$ is the angle of the helix, and is, therefore, the angle that the teeth of the worm wheel must be cut in order to work properly with a worm having a diameter equal to the diameter of the cylinder and a pitch equal to that of the helix.

The circumference of a cylinder, being a circle, may be found from the following: The circumference of a circle 1 inch in diameter is 3.1416 inches, and the circumference of a circle varies directly as the diameter. Therefore, we have the following rule.

**To find the circumference of a circle when the diameter is given.**

*Multiply the diameter of the circle by 3.1416.*

Example.—Find the circumference of a circle 10¼ inches in diameter.

Solution.—By the rule, we have circumference = 10¼ × 3.1416 = 10.25 × 3.1416 = 32.2014 inches. Ans.

In the case of a worm, the diameter of the cylinder should always be considered equal to the diameter of the pitch circle, which is twice the distance from r to p' l' in Fig. 1.

Example.—At what angle should the teeth of a worm wheel be cut, if it is to work with a worm whose pitch diameter is 4 inches and the circular pitch of whose threads is ¾ inches.

Solution.—According to the preceding principles, first find the circumference of the pitch cylinder. The diameter being 4 inches, its circumference = 4 × 3.1416 = 12.5664 inches. Draw a horizontal line 12.5664 inches in length. From one end of this line, draw a line at right angles to it and make this line equal to the pitch = ¾ inches. Draw a line from the other end of the horizontal line to the free end of the second line drawn, thus completing the triangle. The angle between the horizontal line and the last line drawn is the angle at which the teeth should be cut. Ans.

### EXAMINATION I.—Continued.

11. What kind of a curve is formed by the thread of a worm?
12. What is a helix?
13. How is the distance dc', Fig. 2B obtained?
14. What form will the helix have when the cylinder is flattened out as in Fig. 2B?
15. Show by a sketch at what angle the teeth of a worm wheel must be cut if it is to work with a worm 6 inches in diameter and having a circular pitch of 2 inches.

NOTE.—Persons desiring a thorough education by mail at a small cost in Mechanical Drawing, Machine Design, Mechanical Engineering, Electrical, Steam, Sanitary, Civil or Mining Engineering, Metallurgy, Newspaper Work, Business, Stenography, Bookkeeping, and the English Branches, etc., should write to the United Correspondence Schools, 154 Fifth Avenue, New York, stating the subjects in which they are interested. The schools will send to such parties their catalogue D and full particulars free of charge.

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## A NEW EXPANDING MANDREL.

We have received from Mr. C. E. Dowd, of Louisville, Ky., the accompanying drawing and description of a new expanding mandrel which is the invention of Mr. H. Berner, of the same city. The object sought is a mandrel that will give two simultaneously expanding parts and allow disengagement from the work by driving endwise on the core which carries the expanding devices. To accomplish this result it is necessary that wedges shall taper the same way at each end of the mandrel, since a construction in which the tapers are opposed will give trouble when an attempt is made to remove the mandrel by driving on the end. The motion endwise has a tendency to loosen one set of wedges, but it tightens the other set at the same time and thereby gives trouble. The details of this mandrel, which overcomes the trouble mentioned **by** having the **tapers** extend in the same direction, are shown quite clearly by Fig. 1 The wedges referred to are shown in the detached view, Fig. 2, which also shows the coil spring B, that holds the parts together. An expanding shell adapted to go over the wedges is shown at Fig. 3. In Fig. 1 two sets of wedges are shown at E E and the tapered parts over which they fit, D and C. The bushings H and J are relieved so that they may pass over the ends of the tapered parts D and C for a short distance. The nut I is for expanding the wedges and the lock nut is for securing it in position.

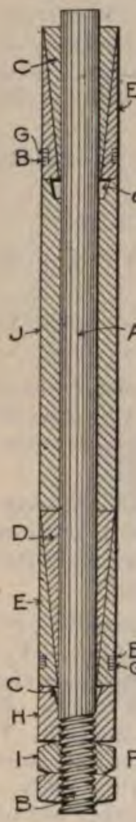


FIG. I

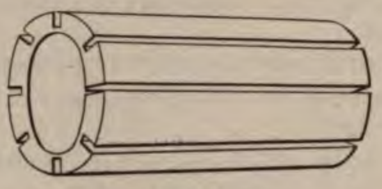


FIG. 3

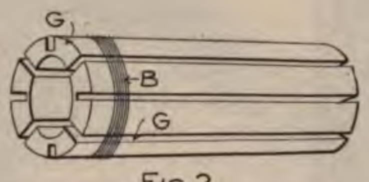


FIG. 2

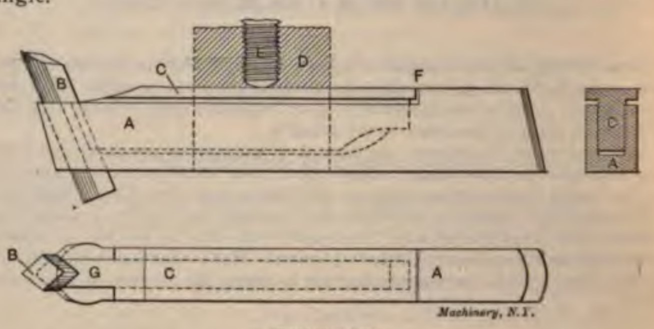
*Machinery, N. Y.*

When a pulley or similar piece is to be turned, the mandrel is put in the bore and the nut I screwed against the bushing H. The wedges E are forced over the tapered part D and are thus expanded into the bore of the work. Simultaneously, the wedges at the other end are expanded by being forced along by the bushing J. When the work is finished the nut I is loosened and the mandrel loosened by a light blow on A at the threaded end.

* * *

## A SIMPLE INSERTED TOOL-HOLDER.

We illustrate herewith a new tool-holder for inserted cutters which is quite novel in its construction, having no set-screws for holding the cutter, but depending on the clamping effect of the screw in the tool-post to hold the cutter in the holder. The holder A is milled out on top for the part C which abuts against a shoulder at F and against the cutter B at G where it is shaped to the form and angle of the tool. The pressure of the cut also tends to tighten the cutter in the holder but not to an extent that in any way interferes with its removal when necessary to change it or to alter the elevation of the point. The feature of elevation of the cutter makes the tool of considerably more value on some classes of work than the ordinary form of diamond point, as the edge of the cutter can be held at the best position for turning without tilting in the tool-post and, at the same time, it keeps the clearance and top rake at the proper angle.



Tool Holder.

Mr. F. W. Roebbel, of the Missouri Pacific Railway, St. Louis, Mo., who is the inventor of the tool, says that he has given it some very trying tests with the most satisfactory results. Driving wheels for locomotives have been turned successfully with it. As is well known, these tires are made of very hard steel which often hardens in "nigger-heads" at points where the wheels have skidded or slipped on the rails, thus making a very difficult material to handle even with the best of ordinary tools.

* * *

## NEW TOOLS OF THE MONTH.

**Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.**

Lag-Screw Cutting Machine: Baker Bros., Toledo, Ohio. Designed for cutting the screw-threads on lag screws.

Shaper: Putnam Machine Co., Fitchburg, Mass. Four sizes of this machine are made, ranging from 12-inch to 25-inch stroke. The ram is driven by a crank motion, which gives practically a uniform speed during the cutting stroke.

Tool Holders for Inserted Tools: New holders have been brought out for lathe and planer tools by F. W. Roebel, St. Louis, Mo., care of Missouri Pacific Ry. Shops; Hoggson & Pettis Mfg. Co., New Haven, Conn., and Doolittle & Graham, Meriden, Conn.

Bench Lathe: The Cataract Tool and Optical Co., Buffalo, N. Y. The lathe is 7-inch swing and has an index attachment for milling.

Portable Tool Rack: The New Britain Machine Co., New Britain, Conn. A convenient receptacle for tools, finished work or castings, consisting of two metal shelves or trays supported by a light framework upon castors, so that it is easily moved.

Universal Monitor Lathe: Dreses, Mueller & Co., Cincinnati, O. Intended for general brass work and specialties where it does not pay to make special tools; 13-inch swing.

Power Hammer: Beaudry & Co., 8 Oliver St., Boston, Mass., This hammer has several important improvements, including a new frame which is massive and has a very convenient arrangement of the anvil.

Power Press: The E. W. Bliss Co., Brooklyn, N. Y., have added to their products a double-geared press adapted to a wide range of heavy work. It will cut iron blanks, cold, 12 inches in diameter by ¾ inch thick.

Molding Machine: The Maywood Foundry and Machine Co., 507 Monadnock Building, Chicago, Ill. This machine is portable and is operated by hand power.

Bench Drill: The George Burnham Co., Worcester, Mass. Designed for drilling ⅜-inch holes or less. This company are also prepared to supply a power feed to their sensitive drills when desired.

Twist Drill Grinder: The Fuller Mfg. Co., Kalamazoo, Mich., have made an improvement in the "Yankee" twist drill grinder which they manufacture, whereby the number of adjustments required is reduced.

Engine Lathe: Schumacher & Boye, Cincinnati, Ohio, are building a 28-inch lathe, driven by a motor, mounted directly on the spindle.

Upright Drills: The Cincinnati Machine Tool Co., Cincinnati, Ohio, are building a 24-inch upright drill, with back gears, quick return, and the usual feeds found on such machines.

Multiple Spindle Drills: The Baush & Harris Machine Tool Co., Springfield, Mass., and the F. B. Shuster Co., New Haven, Conn. Both described in this number.

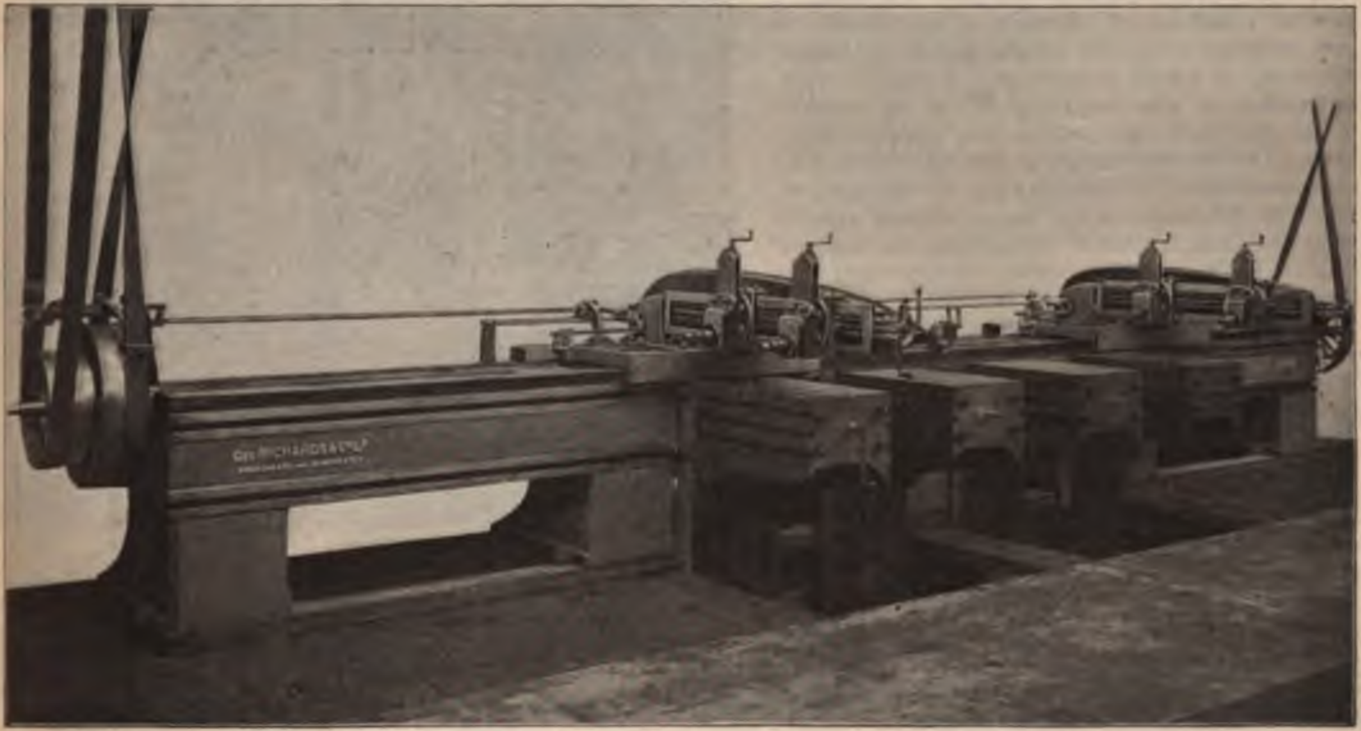
# MACHINERY.

**Vol. 6.** **April, 1900.** **No. 8.**

## A MANCHESTER WORKS AND ITS PRODUCTS.

James Vose.

Having occasion to visit the works of Messrs. Geo. Richards & Co., Ltd., Broadheath, Manchester, Eng., I had the opportunity of inspecting a newly-finished side planer, which would appear to be the largest yet built, in Europe at any rate. The shop in which it had been erected, has only recently left the builders' hands, but it promises to be a useful addition to an already well-laid out works. The only shop tool then at work in this extension was a Sellers planer, capable of planing a length of 35′ by 36″ square. A long side planer bed was being operated on, both cross-rail tool boxes being at work removing a cut from ⅜″ to ⅝″ deep, and as the Mushet steel tools were particularly well ground, as regards shape and cutting angle, it was a pleasure to watch the chips curling away from the casting. Two powerful travelling cranes, pending the arrival of their electrical driving gear, were being worked by hand, manipulating the heavy castings dealt with by the Sellers planer and the erecting floor hands.



A Large Side Planer.

Before proceeding further with the description of the side planer, it might not be out of place to give a general description of the works and its output. These works, now covering nearly four acres of ground, were the pioneers in a district about five miles out of Manchester, and owe many of their characteristic features, as regards construction and products, to the organizing and designing abilities of Mr. Geo. Richards, who, for a number of years, was prominently identified with the firm. They are well situated as regards railway and canal facilities. The Bridgewater canal—the first carried out by Bundley, "the father of inland navigation"—passes close to the works, and a railway siding connected to the shipping department enables goods to be delivered to all the principal railways, and also saves much handling of raw material. One flourishing section of the works is the power-transmission department. This is entirely separate from the wood-working machinery and tool-building departments, and it is self-contained in every particular. Its equipment includes a very efficient and productive pulley-boring machine, designed on unconventional lines by Mr. Geo. Richards.

The adjustable swivelling hangers and pedestals, and the split pulleys, which have cast iron arms and hubs and steel rims, commend themselves to the eye of the mechanic, and their design shows unmistakable traces of that instinct, or faculty, of designing as distinct from inventing, recently mentioned by Professor Sweet in his address at the opening of the session of a trades school. The mean appears to have been arrived at between the, at first sight, fragile hangers used in America—but which I have never known fail to answer their purpose—and the extremely substantial fixtures made in the past by eminent English firms for carrying fixed bearings. In consequence of the present extensive additions to motive power plants in all classes of business, the carrying on of this branch is no sinecure. The wood-working machinery manufactured by Messrs. Richards & Co. includes very efficient types of band and circular saws, planing machines and special tools for pattern shop use. In the metal-working machine tool lines, the various machines have distinctly characteristic features, and the number of types occupies a position about midway between those produced by extremely specialized American tool works and a reputable English concern building lines ranging from powerful hydraulic tools to projectiles and special textile machinery.

Electrical driving is adopted here, the tools being driven in groups from line shafting, each line shaft working from its own motor. Their own installation of machine tools includes examples of their own lines, other representative English tool builders, and some of the latest American productions, including Brown & Sharpe milling and gear-cutting machinery, Gleason bevel-gear planers, Colburn key-seaters, etc. Somewhat of a novelty is the gap-bed lathe, manufactured by the American Tool Works Co. I was informed that, on the general run of work, the gap-beds had not proved disadvantageous, but were, during the present rush of work, of material assistance on occasion. Returning to the 48" side planer, as will be seen from the illustration, it is fitted with two overhanging arms. Each arm is operated by an independent screw, driven from its own countershaft. These screws are of ample diameter and are fitted with special thrust collars. Each of the arms will plane a width of 48", and a length of 20' when one of the arms is stationed at the extreme end of the bed. Both arms may be working simultaneously, providing the total length of stroke does not exceed 20'. Two tool boxes are provided on each arm, each having automatic cross and down feeds, and being arranged for planing angles. I might here point out that, in common with many English firms, Messrs. Richards make provision for taking up wear on the pin on which the tool rest or clapper box swivels. I have not seen this feature on any American shaper or planer. It would be interesting to know the reason for this omission.

Four tables are provided for holding the work. It will easily be seen that the machine is capable of dealing with a wide range of work as, to quote the firm's description: "Four cuts can simultaneously be taken off one casting, or two cuts off two separate castings, or four separate rows of small castings can be planed at the same time." The belt shipping and feed arrangements are brought well up to date, and the tool altogether appears likely to prove a most useful addition to the range of sizes in which the side planer is built.

Chatting on general topics, the American system of working hours is in use in these works, and is apparently found advantageous by the firm. Personally, I have no experience of the merits of the system, but have never heard it spoken of enthusiastically by English workmen. A system of piece work is also in vogue, and appears to give mutual satisfaction, no reduction in the piece-work rates having been made for many years. The beneficial effects of this last feature were commented on by Mr. Matthewson, the managing director of the works, in the course of some remarks addressed to a deputation representing the staff and employees, who wished to convey to the directors their appreciation of the hospitality extended to them and their families on July 3, 1899. This token of good feeling manifested by the firm to its employees took the shape of a well planned picnic attended by about 1,000 participants. The speaker considered that much of trades union opposition to piece work and kindred systems had probably arisen through ill-considered and uncalled for cutting of piece-work rates by more or less shortsighted employers in the past. As American interests are well represented on the management of the concern, the workmen requested and obtained a holiday on the day following the outing, so that in one case at least, the 4th of July was duly celebrated by British workmen. In conclusion, it may be added that, at the present time, extensive additions to the buildings and plant are in contemplation, and will probably be taken in hand shortly.

* * *

It is generally recognized that as mankind advances in intelligence and experience he does pretty much the same things at the same stages of development the world over, although, perhaps, in a little different way. And so it is, we suppose, that we received at nearly the same time accounts of two actual instances where two different would-be or hope-to-be mechanics used a ladder in lacing a belt and laced the belt through the ladder so that the job had to be repeated. One of these accounts was related of our friend Jones, of Jones Engineering Company fame, and the other is told of by our new contributor, "Junius," in this number of the paper.

* * *

The scale on cast iron is very hard on the cutting edges of lathe tools and milling cutters and the endeavor is always to cut at sufficient depths to get beneath the scale. If the castings have so little stock that it is not possible to do this, the abrasive action of the scale can be overcome by "pickling" the castings in a solution of diluted sulphuric acid.

## NOTES FROM THE SECOR WORKS

### AN OIL ENGINE FOR DIRECT DRIVING—ENGINE DETAILS—A NOVEL METHOD OF BALANCING.

The Secor oil engine was illustrated and briefly described in the May, 1899, issue of MACHINERY, and in Fig. 1 the same type of engine is shown directly connected to a lighting dynamo without the interposition of a flexible coupling, which is usually necessary on internal combustion motors.

The Secor engine is an oil engine operating in the Otto cycle, but with the governing accomplished by the regulation of the amount of charge fired and not by the hit-and-miss plan. Thus a charge of a quantity that depends entirely on the amount of work being done is fired at every other down stroke of the piston. The regulation obtained approaches that obtained in the best high-speed steam engines and is effected by a micrometric measuring device, controlled by a shaft governor, for exactly fixing the amount of oil and air to the requirements of the load.

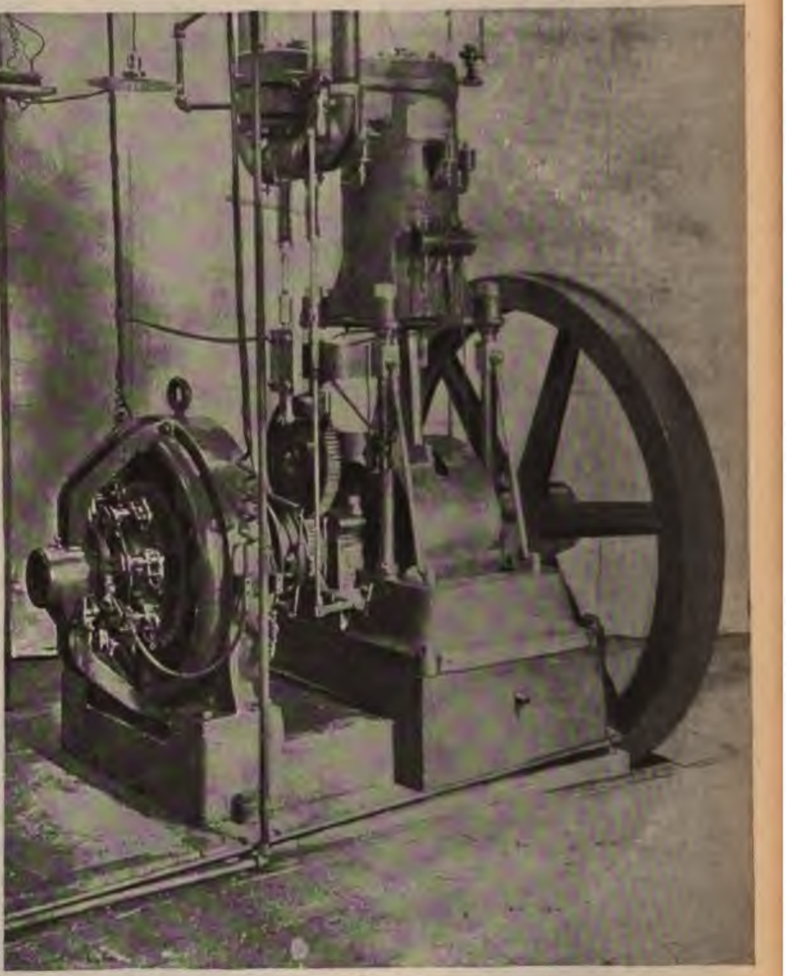


Fig. 1. Direct Connected Oil Engine and Dynamo.

That this system of governing is quite efficient was recently shown to the writer while at the Secor Works, in Brooklyn, N. Y. The engine and dynamo shown in Fig. 1 are run at a speed of about 350 turns per minute, and, as before stated, the shaft connection between the two is absolutely rigid. With a load of 100 incandescent lamps, the voltage remained perfectly constant, and when this load was thrown off or on, the deflection of the voltmeter was not more than two or three volts. As the efficiency of the dynamo was rated rather low, the power delivered by the engine was probably about 10 H. P., which is a fair load for this size of engine. The switchboard was so arranged that 65 additional lights could be thrown in on the same circuit. When this was done, there was, of course, a heavy overload, but the regulation of the engine was such that the voltage did not drop more than four or five volts from the standard. When it is considered that the engine is a single cylinder and that a charge is fired at only every other revolution or an impulse given only one-quarter as many times for the same rate of rotation as would be the case with a steam engine, it will be seen that the performance witnessed is quite unusual. Of course a heavy fly-wheel is used, but, it is said, not as heavy as those usually put on internal combustion motors of the same or less power.

As will be seen, this engine is of peculiar construction, the uprights supporting the cylinder being merely steel tie-rods braced by the diagonal stays at the sides. This construction favors inspection of parts and makes a lighter engine for the same strength than would be the case if cast iron was used throughout.

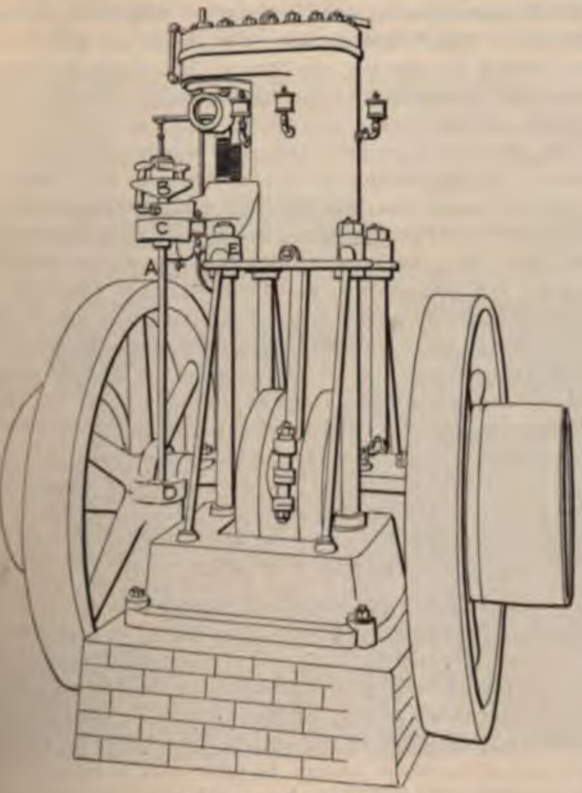


Fig. 2. New Type Engine.

A new model has recently been designed in which the construction and mechanical arrangement are somewhat changed, as will be seen from Fig 2. The diagonal stays are connected to the cylinder casting at E instead of to the sides of the tie-rods, as in Fig. 1. The operation of the valve-gear is effected through spiral gearing. The vertical shaft A is driven directly from the engine shaft by the spiral gears inclosed in the case marked D. The governor of this engine is at B instead of on the engine shaft. The vertical shaft A gears into a horizontal shaft at C which carries the cams operating the inlet and exhaust valve. On this engine the gravity feed apparatus is replaced by a pump and suction charging device. While the gravity feed apparatus has always proved eminently satisfactory when the engine is operated by competent attendants, there is the danger of flooding the cylinder and thereby causing destruction by fire. To meet the requirements of the insurance underwriters, the pump and suction feed apparatus has been developed.

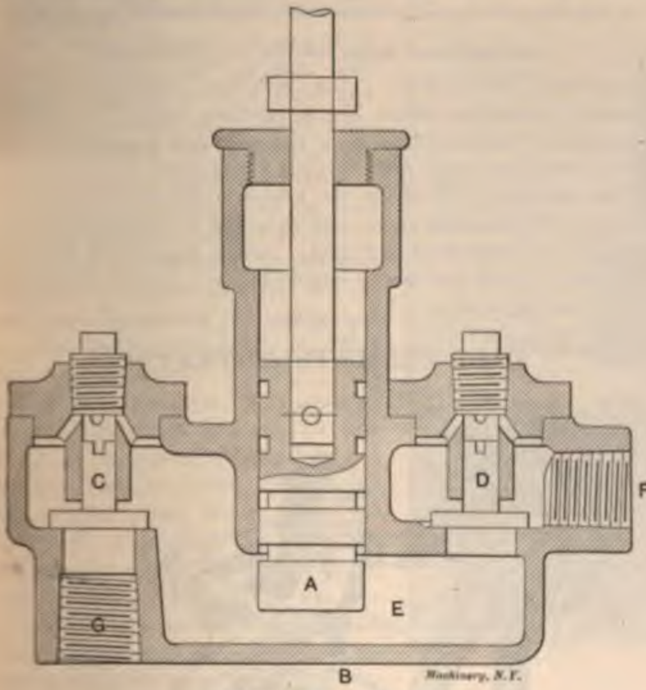


Fig. 3. Details of Pump.

The pump is shown at Fig. 3 and is of very simple construction. The plunger A works freely in its cylinder and has no packing beyond that furnished by the grooves shown, which operate in the same manner with oil as with grooves cut in pistons for the so-called "water packing." No packing is used around the piston-rod and in fact no attempt is made to secure any very close working fits. The inlet valve is at C and the outlet valve is at D, the oil, as it pumped, circulating through the chamber E. The reason that such a simple and obviously leaky construction can be used, kerosene being one of the most penetrating liquids known, is that the pump is made to have a capacity of four or five times that required, the surplus pumped being allowed to overflow from the small reservoir from which the cylinder is charged, and return to the tank. Since the capacity of the small reservoir referred to is that of a small glass oil cup, it is obvious that a dangerous quantity of oil cannot be introduced into the cylinder.

A point in the construction of the connecting-rod brasses on the new type of engine is worth noting. The connecting-rod is made in the form of the well known marine type, but the bolts holding the brasses are somewhat different from those usually employed. Instead of having a head at one end, nuts are used at both ends and the bolt has a collar in the middle, as shown at C, Fig. 4. The object of this construction is to enable the brasses to be slightly slacked, if demanded, by a warm crank-pin without necessarily loosening the bolts and both brasses, thereby causing them to wear and become shaky. Another good feature is that the lower brass B can be removed without loosening the upper brass B, or without being troubled with its dropping down when removing the lower brass, as is the case ordinarily.

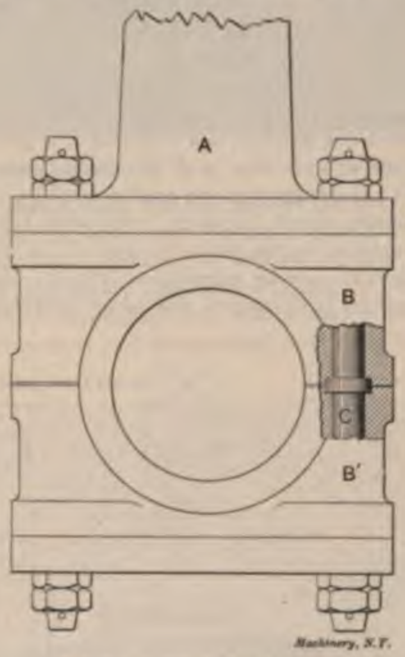


Fig. 4. Connecting-rod Details.

The pistons of oil or gas engines are usually a problem in that it is quite difficult to make them so that they will stay tight. The conditions under which they operate seem to be specially trying in this direction. Probably one reason for the trouble is the universal employment of the trunk piston on this type of engine, which also acts as a cross-head and thus tends to wear the cylinder elliptical in section and not uniformly throughout its length. The piston and piston packing of the Secor engine are shown at Fig. 5. The rings are made eccentric, that is, with the portion opposite the cut somewhat thicker than at the opening. After being cut and beveled, they are sprung together and turned to exactly fit the cylinder. To avoid distorting them to get them in the grooves of the cylinder, as would be the case if sprung in in the usual way, the piston is made so that the rings may be put on from the end and still be in separate grooves. The bull-rings C C are made with one-half the groove for the packing rings B B B in each, and when assembled on the piston they present three complete grooves. The insertion of the packing rings is, therefore, only a simple matter of removing the follower plate A which is held in place by four filister head screws, and the bull-rings, to be replaced in order with the packings between.

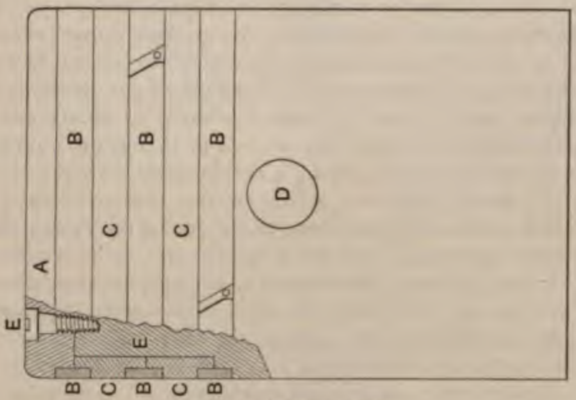


Fig. 5. Piston Details.

The development of a practical motor for automobiles is a problem that is of tremendous difficulty, the conditions being such that a successful motor must contain a number of features unnecessary in ordinary stationary or marine practice. One of these features is to be perfectly free from vibration. To balance an ordinary reciprocating one-cylinder engine so as to eliminate vibration when not fastened to a foundation, is practically impossible, as action and reaction in all directions cannot be balanced.

Mr. Secor has designed an oil engine working on the reciprocating principle, which, however, overcomes the difficulties of balancing incident to the ordinary type. It is not an ordinary engine, as will be seen by reference to Fig. 6. The principle on which it operates is likened to that which would take place in a cannon having no breech if it were loaded in the middle with a charge of powder between two projectiles. If the projectiles were of equal weight and had the same frictional resistance in the barrel of the gun, action and reaction would be equal between them and both would be projected an equal distance while the reaction or "kick" of the cannon would be nothing. Working on this principle, the motor roughly outlined in Fig. 6 is to be developed. The charge is to be fired in the chamber X between the two pistons H H′, whose motion is transmitted to the cranks G G′, having equal throw and set at 180° apart on the crankshaft.

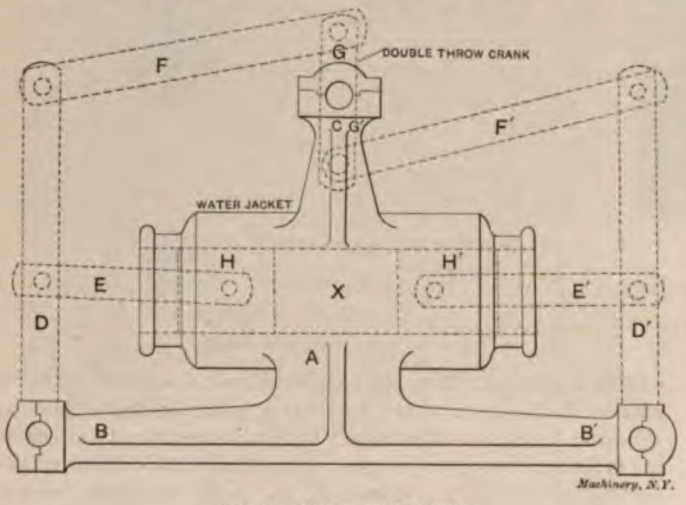


Fig. 6. A Balanced Engine.

The pistons are connected by the short connecting-rods H H′ to the vertical levers D D′, which transmit motion to the cranks through the connecting-rods F F′.

It will readily be seen that action and reaction are absorbed by pistons traveling in opposite directions and at the same speed and also that parts like connecting-rods, whose movement is complex and difficult to balance, are here balanced by a similar part moving in an exactly opposite direction.

* * *

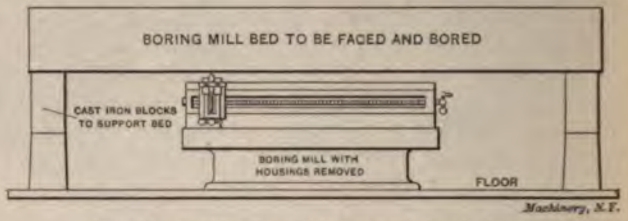
A writer in London "Engineering" states that American and English manufacturers exhibit a marked difference in their willingness to impart information. The American will, as a rule, not hesitate to take any one through his works and show him any novel methods that he may have adopted. English and Continental manufacturers, however, do not thus open their works to the public and are not anxious to supply information to the public. In commenting on this, a writer in the "Engineering Magazine" says, that the generally accepted European idea is undoubtedly that secrecy is the key to success in manufacturing, and adds, "Is it not true, moreover, that this system tends to preserve and perpetuate methods and machines which have elsewhere been discarded as obsolete? A few years ago an American visitor to some English establishment was surprised at the difficulty he experienced in obtaining access to workshops, and still more surprised and amused to find, eventually, that the carefully guarded machines and processes of manufacture would have been considered quite out of date in his own country." To this it may be said that it is not necessary to go to England to experience this condition of affairs.

* * *

## AN AWKWARD JOB.

A boring mill is being built by William Sellers & Co. with non-adjustable housings that will swing work 28′ in diameter.

To bore the hole for the table spindle and face the circular bearing was something of a problem, as there is no tool in the shop large enough to handle such a piece. The way the bed was machined is indicated in the sketch. The housings of a boring mill were taken down, leaving the table with its driving mechanism in place. The bed of the large mill was then "chucked" over it and with its top down. The hole was bored by a fixture bolted to the table, which had a traveling head. The circular bearing was machined by the rig shown which is a special cross-rail bolted to the table and carrying a tool slide.


BORING MILL BED TO BE FACED AND BORED
CAST IRON BLOCKS TO SUPPORT BED
BORING MILL WITH HOUSINGS REMOVED
FLOOR
Machinery, N.Y.

Milling a Large Boring Mill Bed on a Smaller Mill.

The bed was held up by the cast-iron blocks shown at the corners. In this manner, the bed weighing many tons was bored and faced without much difficulty. Such a feat would, however, be difficult if not practically impossible in a shop not equipped with traveling cranes.

* * *

## SHOP TERMS ILLUSTRATED.

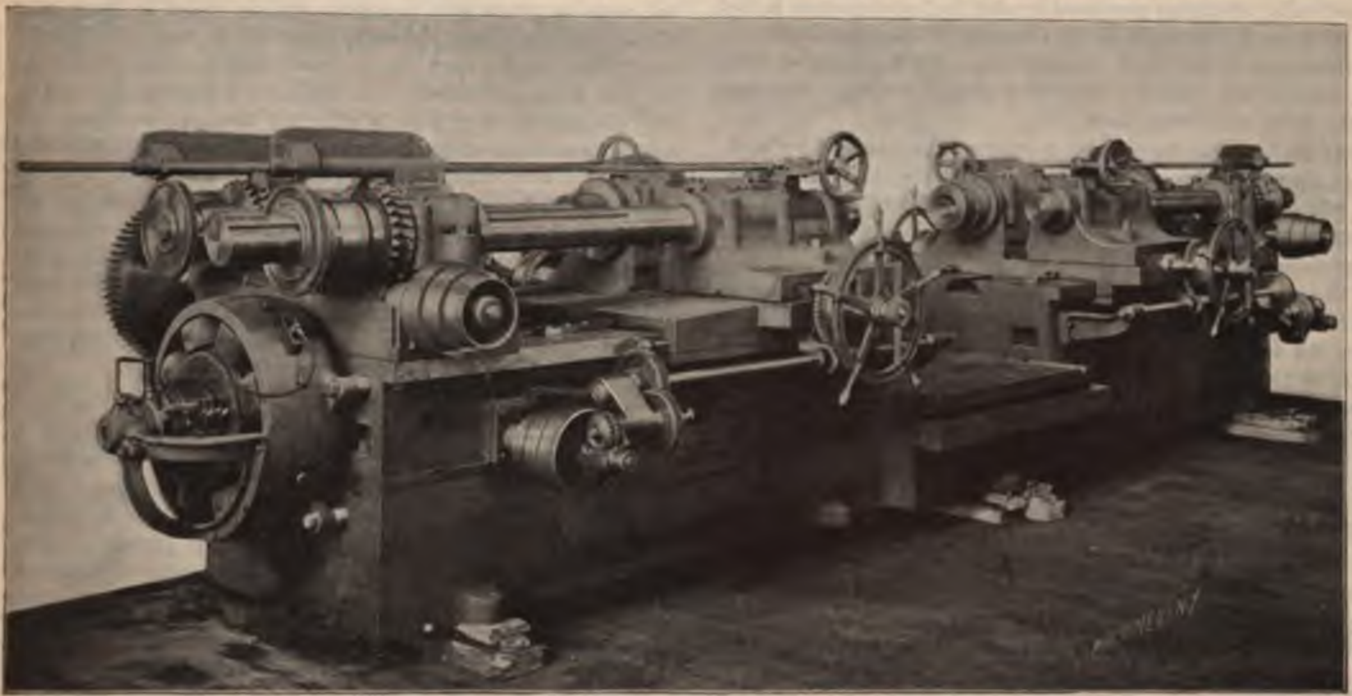
Machinery N.Y.

CENTER PUNCH.

## SPECIAL BORING MACHINE.

The machine shown in the accompanying engraving is an excellent example of the special tools being built for doing any kind of machine work when the quantity of the work to be done warrants the cost of the permanent investment required.

This tool is made for boring and facing the steel frames of the railway motors used on street cars, at one setting. The frames of these motors being of steel, a machine for boring and facing them rapidly must, necessarily, be of the most rigid construction and have a very powerful drive. The boring machine shown is one specially designed for this class of work by the Newton Machine Tool Works, and is said to fulfill all the requirements satisfactorily. The machine is driven by the independent motor seen attached to the end of the frame. The steel spindles, of which there are four, 6" in diameter, are driven by hardened triple thread worms engaged with phosphor bronze worm-wheels. The worms being made with right and left-hand threads, when both spindles at the same end of the machine are at work, the thrust is partially, if not wholly, balanced. The spindles are adjustable horizontally both longitudinally and laterally, so that motor frames of various sizes can be machined by shifting the position of the spindles to agree with the center distances required.


Newton Four-spindle Boring Machine for Railway Motor Frames.

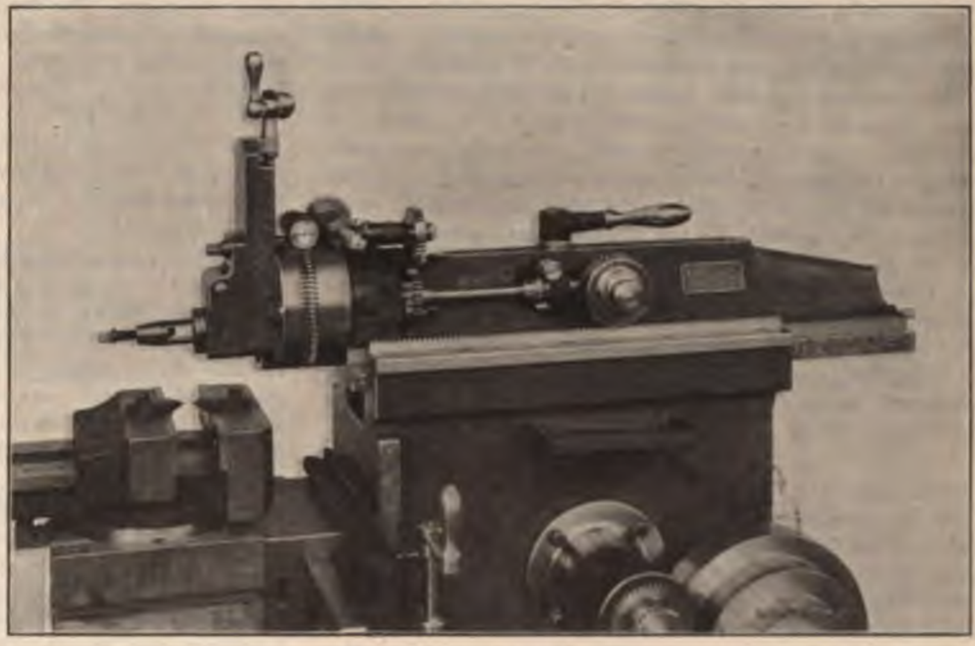
The field magnets of a railway motor frame are bored on this machine at the same time the hole for the car axle is bored. The facing and counterboring of the frame for the heads supporting the armature bearings is also done at the same setting, the boring tool being removed from the socket in the spindle and replaced with a special head for facing and counterboring. The motor frames are held in a special jig when being bored, the jig being so constructed that it automatically takes the correct position when lifted into the machine.

On the first machines of this type built by the Newton Company, it was necessary for the operator to be at the end of the machine to engage or disengage the feeding mechanism clutch. To obviate this unhandy feature, the machine shown is built with the shafts and hand-wheels seen over the main spindles, which enables the operator to engage or disengage the feed clutch without leaving the center of the machine. The longitudinal feed is controlled by the clutches in the pilot wheels at the side.

While this machine is designed for railway motor work, it is, however, as well adapted to some other classes of work in which it is necessary to bore parallel holes, such as duplex pumps, etc. The holes being bored in such a tool at one setting, time is saved and the parallelism of the holes assured.

## SHAPER FEED MOTIONS.

The accompanying illustration shows the application of a down and an annular feed motion as applied by the Springfield Machine Tool Company, Springfield, Ohio, to one of their shapers. While it is evident that both of these feeds are not required at once, they are so arranged that each is at instant command. Motion to the feeds is transmitted through the agency of the gear which meshes with the rack, and this gear in connection with a pair of friction discs and a pair of bevel gears operates the shaft at the side of the ram.


Novel Shaper Feed Motion

The amount of reciprocating movement to regulate the feeds is determined by two stops, one fixed, and the other changeable by means of a small knurled knob, shown at the left of the gear which engages the rack. This permits regulation of the feeds, while the machine is in motion, from zero to the greatest range.

The down feed is thrown in or out with a pawl on the lower gear, and the upper pawl takes care of the circular feed. Both of these pawls are reversible so that motion in either direction is obtainable. Should the shaper be used for any length of time, when automatic feeds are not desired, the gear which runs in the rack may be withdrawn so that no motion takes place. A feature of particular advantage possessed by this feed arrangement is that the stroke or the position of the ram may be changed to suit the requirements of the work, without altering the degree of feed, and without the necessity of making any adjustments whatever on the down or circular feeds.

It is obvious that the circular motion can be operated by hand, by placing the crank on the square end of the shaft which is at the side of the swivel head and very conveniently placed for the operator, who need not change his position to make any adjustment required.

The circular head is fitted to revolve on the end of the ram in carefully constructed bearings, so that no lost motion takes place when the circular feed is in use, and it can be securely clamped at any angle by two nuts, in the usual place, just as in any regular swivel head.

The amount of power required to drive the feeds is very slight, and the friction discs are fitted with an adjusting nut, so that any wear can be compensated for, and any required tension obtained.

* * *

## ITEMS OF MECHANICAL INTEREST.

### NOTES OF PRACTICAL VALUE GATHERED FROM VARIOUS SOURCES.

A representative of Greenwood & Batley, Ltd., the English manufacturers of the De Laval steam turbine, states that the tests on a 300 horse-power turbine of this design show a steam consumption as low as 13.9 pounds of steam per brake horse-power per hour. If this result is a correct one, it is an unusually good performance, because an engine of this size of standard design would hardly run on a smaller consumption per indicated horse-power per hour and the consumption per brake horse-power would certainly be greater. The mechanical efficiency of an ordinary steam engine is seldom higher than 85 per cent.

---

It has probably been quite a mystery to many how the beautiful engraving on the cheap filled watch cases is performed. Many of these watches with good movements are sold for $12 to $15, with a warranty on the cases for fifteen years. It is obvious that the amount of gold contained in them is so small that it could not have a thickness sufficient to enable any engraving to be done which would remove the metal, as the baser metal beneath would necessarily be exposed. We are informed that the engraving on this class of watches is done by a diamond burnishing tool, which is a rounded diamond set in the end of a steel piece. The diamond is quite minute and when carried through the complicated pattern set by the engraving machine, it does not cut away the metal but grooves or presses the metal back as it proceeds. In this manner the watch case is wrought into the desired pattern and with a covering of gold that is of nearly uniform thickness.

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In the brass foundry of the National Meter Works, Brooklyn, N. Y., an exhaust system is arranged for all the emery wheels used to grind the fins and sprues from the castings. Under ordinary conditions the brass dust is often wasted, as it is so much mixed with dirt and emery dust that it is practically valueless. In this plant, however, the exhaust is carried to a settling chamber where it is separated from the dirt. The result has been that as much as 900 pounds of clean brass grindings have been collected in two months. While these grindings are somewhat difficult to melt, they can be successfully handled by covering them with charcoal when placed in the crucible. The grindings and saw-dust collected from the band-saws used for sawing off the sprues make castings that are all right for the cheaper grades of brass fittings.

The exhausting apparatus thus not only preserves the health of the workmen, but pays a handsome interest on the investment in the value of the brass recovered.

---

"Domestic Engineering" states that a foreman of a gas company, while boring a hole under the pavement so as to get in a service pipe for gas without breaking up the pavement, ran his auger through a lead service pipe connected with a water main. Water was flying in all directions, and as the lead pipe had been laid some 30 years ago, and there was no record to show with what it was connected, the water could not be shut off. Finally the foreman broke open the pavement and jammed the end of the lead pipe, and stopped the water from flowing through it. The conundrum then was how to get the pipe repaired. A plumber was found who was equal to the occasion. He procured a lot of ice and some salt, and packed the mixture around the "live" end of the pipe, and soon froze the water solid in it. He then cut off the jammed end, inserted a piece of the broken length, made two joints, and removed the ice. The pipe soon thawed out and the water flowed through it all right. The spectators who saw how it was done voted the plumber a genius, but he claimed no extraordinary credit for his skill, stopping such leaks being only a part of his business.

---

At a recent meeting of the Central Water Works Association Mr. L. E. Hoit gave a paper upon the efficiency of water works pumping engines and stated that, considering the simple duplex pump, which is the most expensive of any to operate, to require an expenditure of $1.00 to $1.20 for pumping a certain quantity of water, it would be fair to estimate that the compound duplex pump would perform the same service at an expense of about eighty cents; the compound condensing duplex would call for an expenditure of about fifty cents; the compound condensing high duty, about seventeen cents; the triple expansion non-condensing, about thirty-five cents; the triple expansion condensing, twenty-five cents; and the triple expansion high duty engine, about fifteen cents.

If the efficiency of the various machines just mentioned were to be expressed in foot pounds, the duty of each would be respectively 17 to 20 million for the duplex; 25 million for the compound; 40 million for the compound condensing; 118 million for the high duty compound; 57 million for the triple; 80 million for the triple condensing; and about 135 million for the high duty triple expansion. The duty given above for each engine varies, of course, with the different conditions; but it is near enough to enable one to understand the relative cost of operating each machine.

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The "American Machinist" and the "Engineering Record" recently gave two kinks of value to draftsmen relative to cleaning tracings and restoring the glaze. A correspondent to the latter journal says:

Very few engineers or draftsmen seem to know that tracing cloth can be very quickly and easily cleaned, and pencil marks removed, by the use of benzine, which is applied with a cotton swab. It may be rubbed freely over the tracing without injury to lines drawn in ink, or even in water-color, but the pencil marks and dirt will quickly disappear. The benzine evaporates almost immediately, leaving the tracing unharmed. It must, however, be borne in mind that the surface has been softened, and must be rubbed down with talc, or some similar substance before drawing any more ink lines.

The "American Machinist" states that the chief draftsman of the Rushmore Dynamo Works in Jersey City has discovered that the glaze may be restored to tracing cloth after using the eraser by rubbing over the roughened surface with a piece of hard wax from an old phonograph cylinder. The surface thus produced is superior to that of the original glaze, as it is absolutely oil and water proof.

In the Rushmore works all pencil drawings that go into the shop are first rubbed over with this wax, and it has been found that while common pencil drawings are soon destroyed by dirt and grease, those treated with the wax return to the drawing room after the completion of special jobs without the slightest blemish.

## SHOP KINKS.

### ARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

**utions of kinks, devices and methods of doing work are icited for this column. Write on one side of the paper only and send sketches when necessary.**

ncourage our readers to send more descriptions and photographs shop kinks and handy devices, we will give contributors the priv- selecting from the appended list of desirable machinists' tools, ac- to the value of the different devices submitted.
ompete, it will be necessary to observe the following conditions:
ll descriptions shall be written on one side of the paper only.
he necessary sketches to illustrate the device shall be made on sheets from the written matter.
ools shall be chosen from the following list, as no option in the of other tools can be given.
ontributions to this department will be graded, according to value, classes. Contributors will be informed by mail during the month publication, from which class they may make their selections. ment will be made in all cases, if preferred.

| | List Price. |
|---|---|
| ett's No. 9 combination square, 12-inch blade, with center ead and bevel protractor | $4.00 |
| er's No. 100 surface gage with 12-inch and 18-inch spindles | 3.50 |
| mb's No. 17 outside micrometer caliper | 3.50 |
| er's No. 39 combination square with 12-inch hardened blade | 2.50 |
| ett's No. 56 tool maker's case-hardened surface gage, with- ut auxiliary guides | 2.50 |
| mb's No. 12 internal micrometer caliper with depth gage at- chment | 2.50 |
| ett's No. 11 combination square, 12-inch blade, with center ead | 2.00 |
| mb's No. 11 internal micrometer caliper | 1.75 |
| ett's No. 13 4-inch square, with two blades | 1.65 |
| ett's No. 15 universal bevel | 1.50 |
| er's No. 18 spring tempered rule, 12 inches long | 1.25 |
| ett's No. 40 screw pitch gage | 1.00 |
| er's No. 19 flexible rule, 9 inches long | .90 |
| ett's No. 79 outside spring caliper, 4 inches | .75 |
| ett's No. 73 inside spring caliper, 4 inches | .75 |
| ett's No. 83 spring dividers, 4 inches | .75 |

### TOOL RELIEVING DEVICE.

tool-relieving device shown in Figs. 1 and 2 is one that ently seen in the shops of the Waltham Watch Tool Co., ngfield, Mass. The device was being used for raising a tool from the T-slots which were being cut in a table a narrow oil-retaining channel around the outside. The was so narrow that the tool could with difficulty be y hand from the T-slot before the beginning of the back and the use of a strap or any other device to follow the s out of the question. It was therefore necessary to use a mechanism that could be attached to the side of the as to operate within the narrow space of the oil chan- s will be seen, the device mentioned is so made that be attached to the side of a planer, or shaper tool by nary C clamp as shown in the accompanying cuts. iding shoe D is provided with a spindle working the block B and with an adjustable collar at the top. pring between the shoe and the block B, holds the shoe the face of the table being planed. When the end of lot is reached, the sliding shoe falls into the oil-channel ses the planer tool above the table, when the motion is d, as illustrated by Fig. 2.

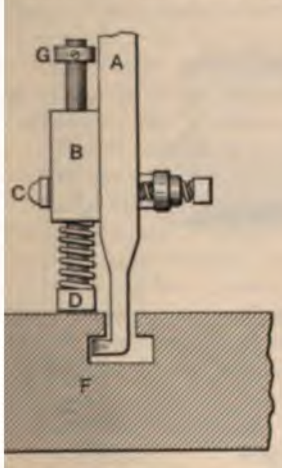

Fig. 1.

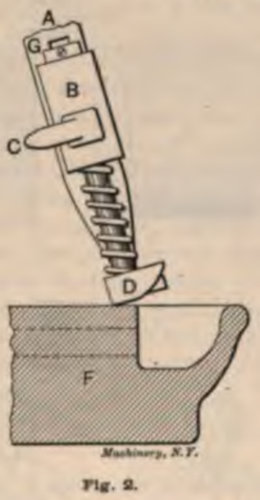

Fig. 2.

### TO DO PRESS WORK IN A LATHE.

Frank Creiner, New York City, sends a scheme for us- ordinary lathe to do the work of a press (where there is the shop), in cutting off any number of short pieces of k. The piece A in Fig 3 is called the punch and is made of tool steel with a tongue planed on its lower side to fit one of the slots in a face-plate. The punch may be secured to the face-plate by machine screws or by a horse-shoe clamp suitably placed. The die B is also made with a tongue on its lower side to fit the slot for the tool post in the cross-slide. To securely hold the die, it is best to drill and tap a hole in the slide and a clearance hole in the die for the filister head screw D, which will hold it in place rigidly. The die B is made, preferably, with the shoulder indicated which acts as a guide for the stock being cut. When cutting the stock, always let the last slot preceding the die pass before shoving the end against the face-plate. The lathe should be speeded up and should be run with the back-gears in. Every time the face-plate turns around the trick is done.

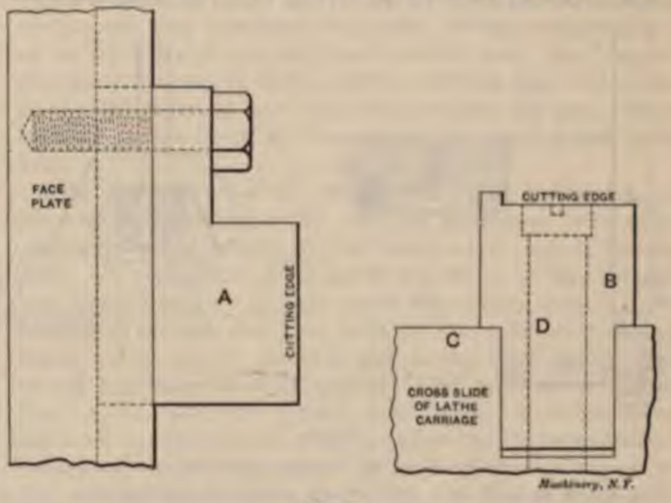

Fig. 3.

### SURFACE GAGE WITH TWO POINTERS.

Mr. Harry Ash, Chicago, Ill., says: I inclose two sketches of a surface gage which illustrate an original idea of my own, which, from personal experience, has been found to be a great saver of time and of milling cutters. While it can be used on the planer or shaper, I have always used it on a milling machine. By its use the operator can raise the table to take any desired chip without testing the cut two or three times and without danger of taking a cut that is liable to break the cutter. This tool is especially valuable on castings, as raising the table and allowing the cutter to revolve in the gritty surface while finding the lowest spot is very disastrous to the cutting edges.

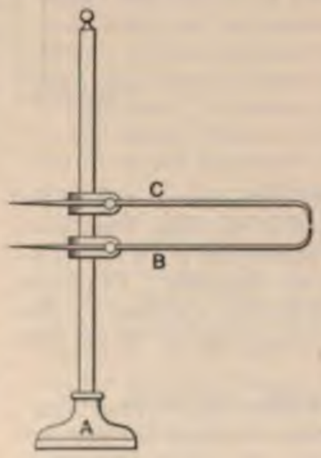

Fig. 4.

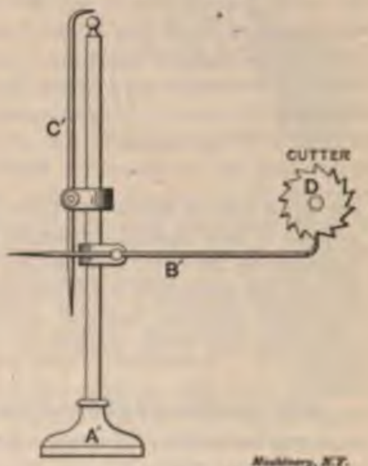

Fig. 5.

To use this surface gage, the pointer marked C in Fig. 4 is set to the lowest spot in the casting and then the pointer is set from it with perhaps 1-32" between the points for a cut sufficient to clean up the surface. Pointer C is then folded up as shown at C' in Fig. 5, and the table is raised until the pointer B will just touch the under side of the cutter as shown at B' in Fig. 5. In this way the table is quickly adjusted to a cut that will clean the casting or other piece being machined, and with no cutting or trying whatever.

### FACING TOOL.

Wilfred J. Thompson, Ingersoll, Can., says that the facing tool shown in Fig. 6 is made by turning the shank A to fit the drilled hole, having an under surface to be faced, and that the shank is squared for about 1½" from the bottom. The lower end of the squared part is provided with a slot for the key C which is an easy fit from either side. The cutter B is made to cut left hand to obviate crossing the driving belt, and is provided with a square hole nicely fitted to the squared end of the shank A. The shank is held in a drill chuck when the castings are being faced off. To use the tool, the shank is slipped through the drilled hole and then the cutter is slipped on and held in position by the key C. The device is shown in place in the casting D. The advantage of the squared shank is that it allows of a much heavier cut being taken than is possible with the ordinary slotted shank having an inserted cutter. A much larger surface can thus be trued up, a feature that is often quite desirable.

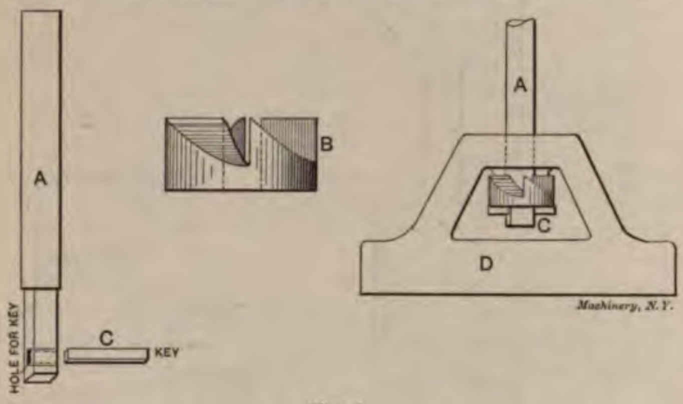

Fig. 6.

### CENTER INDICATOR.

The center indicator shown in Fig. 7 is an easily arranged makeshift for accurately chucking a piece true with a bored hole which is partially concealed by an overhanging flange or lip, as indicated by P. The wire pointer is drilled for the cross wire W which is inserted at right angles to the axis of the pointer. The cross wire W is lightly held between the point of the tool-post set-screw and a hardwood piece H. The bent end B of the pointer is held against the upper side of the hole, being overbalanced by the outer end, and any eccentricity of the hole is indicated and somewhat multiplied by the outer point. To prevent excessive vibration, the end of the pointer is allowed to slide along the side of the block C or an angle iron set on the lathe shears.

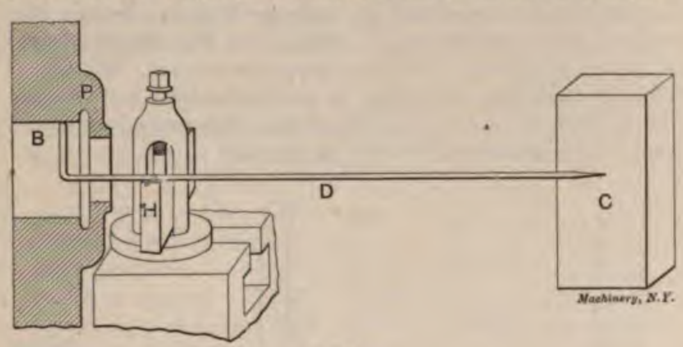

Fig. 7.

### EXPANDING CENTERS FOR PIPES, COLUMNS, ETC.

A correspondent "R" sends a sketch, Fig. 8, and description of an expanding center for pipe, etc. He says that by reference to the accompanying sketch it will be found that piece A is bored and has six ½" square holes broached in it at equidistant points around the circumference, three at each end and equally spaced. The two pieces marked B B' are turned to a sliding fit in A, and 3 taper grooves are cut in each one to match the square holes in A. B is tapped to fit screw G, while B' is drilled out so as to slide freely along G. G is a 1" bolt with a good center reamed in the head end. Pin D is required to keep B' close up to the head of C, while E is required to keep B and B' from slipping clear through A. The two pins D and E are not absolutely necessary but contribute quite a good deal to the successful working of the center. F F F, etc., are ½" square cold rolled steel pins with case-hardened points, several sets of which are needed.

The center, as shown, is complete for a 4" pipe and admits of a ½" variation in size of pipe, viz.; from 3¾" to 4¼", the next set of pins would be made a little longer so as to suit from 4¼" to 4¾", and so on.

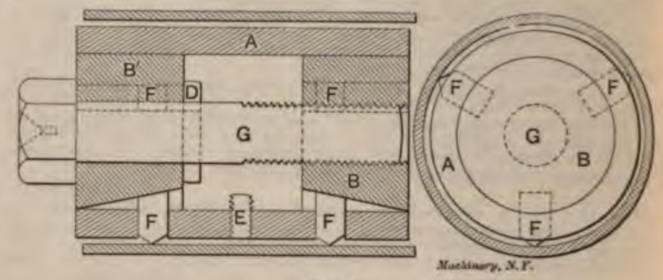

Fig. 8.

In using this center care must be taken to keep it in the position shown in sketch, that is, when putting in or taking out the pipe; the workman can then place one finger on each of the two lower pins so as to prevent them falling out, and the other four pins will, of course, stay in themselves.

The strong points of these centers are their accuracy, low price for making, and facility in operation, as both ends of the pipe can be easily centered in two minutes. Also on account of their length, they are much more likely to be in line with each other than the common "spider" or cone centers used.

### A NEAT FACING RIG.

R. P. Perry, Hoboken, N. J., says that this facing rig for a boring bar was recently called to his attention while passing through a large shop devoted to the manufacture of plumber's specialties.

The principal features of this rig are its neatness and compactness. The tool-holder B is square and is fitted in a square hole passing through the boring bar A. The tool-holder is operated by the screw C and the star-wheel E which are held in place by the wrought iron loop D. The loop is held to the bar by the two tap bolts shown. As will be seen, the tool F can be drawn very close to the boring bar when facing a flange, and, in fact, a flange can be faced to its inner edge when the bar is almost as large as the hole through the piece. This is accomplished by grinding the tool so as to cut with the edge next to the bar and by also having the bar recessed so as to allow the tool to be drawn slightly below its surface.

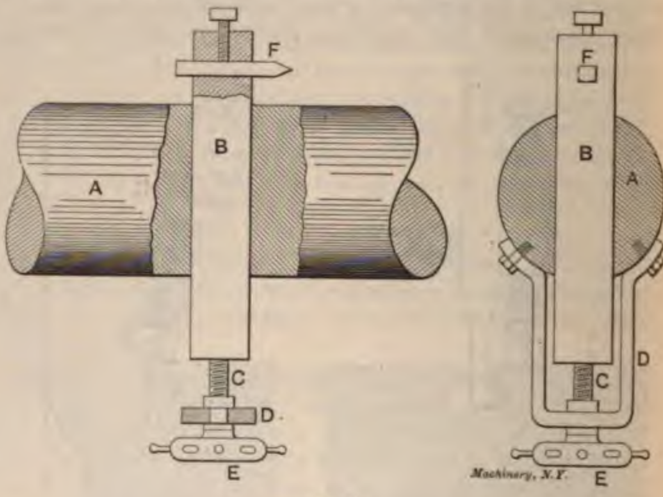

Fig. 9.

* * *

### A CORRECTION.

A correspondent calls attention to the fact that the formula used in question 40 of the February number should be written with the exponent 1.41 applying to the volumes instead of to the pressures, as there given. Subscribers who have the February number will kindly note this correction, since the formula is quite misleading as it was published.

# HE EVOLUTION OF ARCHIMEDES.—1.

## A TRUE BIOGRAPHY.

JUNIUS.

all him Archimedes because that was not his name and be- he had no ambition to move the earth with a lever.

was a green, uncouth sort of a lad at first, brought up in ntry village, 'steen miles from a railroad. He wore cow- boots and a flannel shirt with a paper collar, in the winter, n the summer went bare-foot and wore a cotton shirt with llar at all. For all this, he had yearnings for wheels that and for tools that cut. He fitted up a work-bench from a ry-goods box and stocked it with such tools as he could beg or borrow. He even acquired in some way a nondes- sort of a turning lathe and jig-saw, which gave him cramps s right leg, and where his turning-gauge invariably kept with the churning of his foot. In school he preferred etry to Latin, and out of school he found even the buck- nore attractive than the hoe.

Fig. 1.

An opportunity to work occasionally in a planing mill made him happy, in spite of blistered hands, and so developed his liking for machinery that Archimedes senior became convinced of the boy's aptitude for the shop rather than the college. Accordingly Archimedes had his hair cut bought a new trunk and a suit of store clothes; then one cool October morning bade adieu to his parents from the front seat of the stage and rode away over the hills.

next find him entered as apprentice in the machine-shop of & Ammer, Jobbers in Wood and Iron. To his eyes the oily, grimy room was fairyland, every revolving shaft and ing rod had a mysterious charm, and the men in blue jump- d over-alls, who handled the cranks and pulled the levers, ged to a higher order of beings. Even now the peculiar of iron chips mixed with oil has a fascination for his nos- superior to that of rose or carnation. Archimedes could believe it possible that he was to be permitted to enter sacred precincts and learn these mysteries, still less that he be paid ten cents an hour for doing it. Those who knew hat he must have a jumper and over-alls, too, and that they be of "'hucker-bucker" (brown duck). Now this humble ial, when washed, shrinks worse than the volume of the cy in a panic. Accordingly Archimedes bought his over- rge, as they cost him no more, and when he first appeared scene, "over-alls" seemed to express it exactly. Archimedes was a cleanly lad, and as the shop was certainly dirty, he himself faithfully every day and the over-alls once a But Archimedes did not shrink, or at least only tem- y, and the over-alls certainly did. At the end of the second e concluded that his suit just about fitted him; at the end third week he had doubts. I leave the remaining weeks imagination of the reader.

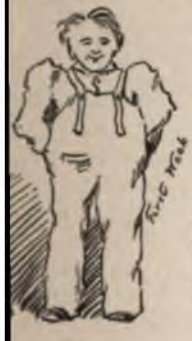

Fig. 2.

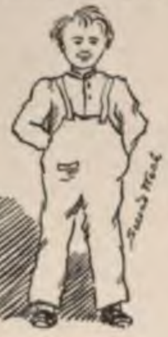

Fig. 3.

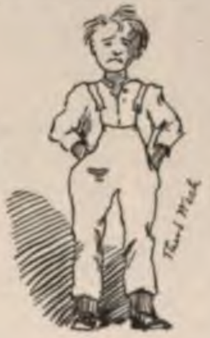

Fig. 4.

When Archimedes entered the shop on that first morning, he was introduced by Mr. Ammer, who was foreman as well as proprietor, to a tangled assemblage of belts, pulleys, gears and grease, called a "gagger." Now this machine was intended to cut bolts and tap nuts, but incidentally, by virtue of its concentrated smell of rancid oil, it could nauseate almost any one in a day of ten hours. Hence its name. "That which we call a rose, by any other name would smell as sweet." A healthy boy of eighteen, working ten or twelve hours a day, cannot be discouraged by any such little thing as a smell. So as Archimedes toiled on from day to day and from week to week, the "gagger" stimulated his already lusty appetite, until the man with whom he boarded began to have deep hollows under his eyes, and the landlady cut the bread still thinner and put more gristle in the hash.

Bang & Ammer had no time system worth mentioning and every man kept his own count, charging up as many hours as his conscience would allow and then throwing in one or two for luck. In rush times, when there was plenty to do, the men were allowed to work as early and as late as they chose. It was the duty of the first man in to build the fire in the shop stove, if it was winter, and to open the gate in the wheel-house which started the water-wheel in motion. Like most shops "Down East" it had cold water instead of hot steam for motive power and there was no boiler to clean, no ashes and clinkers to shovel out, no engine to oil and wipe. There is a gruesome tale of one man who came early and went into the wheel-house to open the gate. The next man who came found the machinery in motion and no one in sight, and went into the wheel-house likewise. The room looked like shambles. The first man in some way had caught his clothes in the rapidly whirling wheel-shaft and was dashed to death.

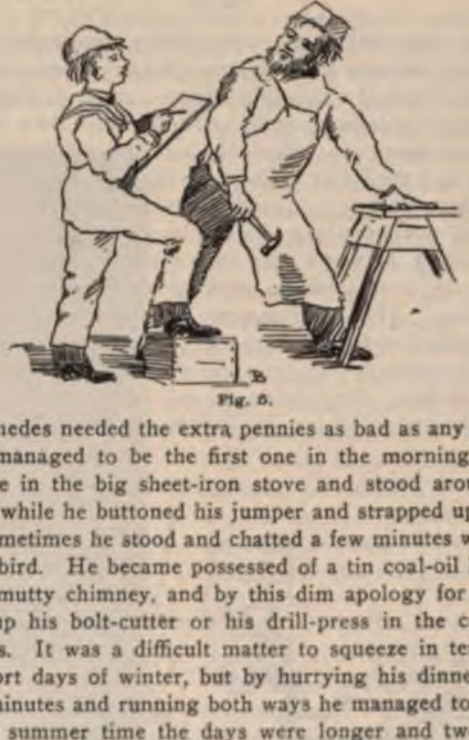

Fig. 5.

Archimedes needed the extra pennies as bad as any one, so he usually managed to be the first one in the morning, built the wood fire in the big sheet-iron stove and stood around in the warmth, while he buttoned his jumper and strapped up his overalls. Sometimes he stood and chatted a few minutes with another early bird. He became possessed of a tin coal-oil lamp, with a very smutty chimney, and by this dim apology for a light he started up his bolt-cutter or his drill-press in the cold winter mornings. It was a difficult matter to squeeze in ten hours in these short days of winter, but by hurrying his dinner down in twenty minutes and running both ways he managed to get there.

In the summer time the days were longer and twelve hours or even thirteen were possible. Bang & Ammer finally concluded that some men were too good to themselves, and that a time-keeper would help check their benevolence. Archimedes was the individual selected for this position, and every morning about nine o'clock, armed with a time-list and a pencil, he hunted up each workman and asked him how many hours he had worked the day before. Even this system had holes in it that a cat might jump through, but after several men had confessed to ten or eleven hours on days when it was easy to próve that they had not been near the shop, there was an improvement in the shop conscience and a corresponding shrinkage in the pay-roll. But this is getting ahead of our story.

It was a proud moment in Archimedes' life when the foreman suggested to him that the overhead belt which drove the counter of the emery wheel was slack and needed taking up. He had often seen the older men do this and knew just how to proceed. He hauled the ladder down from its place over the bolt-cutter and set it up against a floor timber near the belt. He went to a drawer under the bench on the north side of the shop, where the lace-leather and belt-punch were kept and carefully cut a lacing of the right width (he had cut leather whip-lashes from old bootlegs when at home). Fortunately the belt was an open one and there were no complicated problems as to which way to twist it. He cut an inch from its length, punched some new holes and relaced it as he had seen the men do, straight loops on the inside and crossed loops on the outside, fastened the ends and finally managed to slip it on the pulleys, without losing his fingers or breaking his arm. It ran straight and true, quivering with its tightness, and Archimedes triumphantly descended the ladder. But what is this new complication? As Archimedes tries to take the ladder down, it resists and acts as if alive. Looking aloft he sees a tangle of ladder rounds and belts, until there comes over him the sickening conviction that both plies of the belt are running through the ladder. There are but two ways out of it, either to unlace the belt or dissect the ladder, and Archimedes sorrowfully chooses the former, while his shop-mates grin loudly.

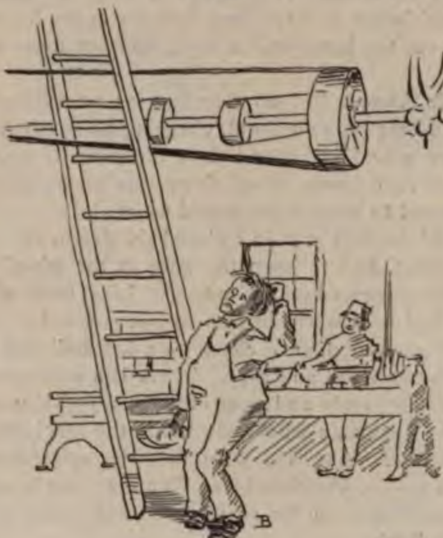

Fig. 6.

At Bang & Ammer's shop they did everything that came to them to do, from mending mowing-machines to re-building a locomotive. The establishment contained wood and pattern shops, foundry and blacksmith shop, as well as the machine shop already mentioned, and our apprentice had more or less to do with all of them. On "melting" days, which came once or twice a week, he had to go into the foundry and "skim" the ladles as the foundrymen poured the molten iron into the moulds. He learned to have a wholesome respect for this same iron and not to wear cotton over-alls or low shoes in its vicinity. Occasionally, a poorly vented cope would rise and let out a cupful of the red syrup, and Archimedes will never forget the day that a ladleful of hot iron struck a rusty chill in the mould and rebounded in a bewildering explosion, throwing drops and spatters of liquid fire to every nook and cranny of the building. The boy can never remember just where he went and what he did, but when he got his wind and his eye-sight, there was a sprawling figure outside each open window and the air was nearly as full of hot language as a moment before it had been of hot iron.

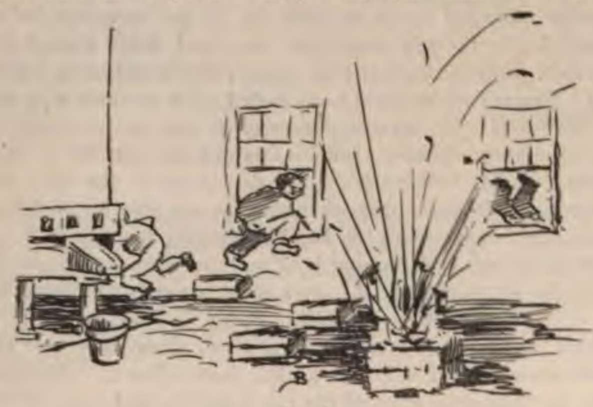

Fig. 7.

This foundry adulterated its pig-iron with scrap, which it purchased from the neighboring farmers and store-keepers—old stoves and kettles, with now and then a plow-point. These last made hard places in the castings which broke the drills and dulled the lathe-tools. Sometimes a load of scrap-iron came on the cars and Archimedes, being only an apprentice, was detailed to go with the teamster and help load and unload the cart. Scrap iron has a great many fine points about it, and when you throw it from a cart to a cupola stage, you find out most of them. Hands cracked and blistered, covered with ashes and soot, these were the disagreeable features. Once in a while came a whole, second-hand cooking range to be broken up. Then how Archimedes enjoyed swinging a ten-pound sledge up over his shoulder, striking a knockdown blow exactly in the center of the top of that range, hearing the crash and seeing the splinters fly. It was worth the price of admission and somehow relieved his feelings. What old relic of barbarism is it that makes us like to smash things?

On other days Archimedes had to go to the blacksmith shop and help old Carl, the smith. Carl was a good-natured man and something of a humorist in his way. Of course the boy was rather awkward at first and the sledge had a habit of going anywhere but in the right place. It would perhaps turn in its descent and strike the chisel of the fuller a glancing blow which would send hot shivers into Carl's fingers and perhaps send the chisel itself whirling to the ground. Carl would swear under his breath and then grin, and Archimedes would get red in the face, but they came to be great friends. Gradually the boy learned confidence, so that the sight of the head of a chisel or the flying hammer of the smith did not make him nervous, and he could get there with his sledge at the right time and place. He had to go to Carl to get his lathe tools and his drills sharpened and tempered. They used the old-fashioned flat drills at Bang & Ammer's, and a twist drill was a curiosity. I think Mr. Ammer had one in his tool-chest but it was only used on great occasions. A flat drill with a square, taper shank has an individuality all its own. It will drill almost any size of hole you want, but it is sometimes difficult to predict beforehand just how big the hole will be. The way to make it run true is to wind paper around the shank, drive the drill in the socket, bend it one way with a monkey-wrench and pound it the other with a hammer. If it does not run true, reverse the process. If you break it, make another. Archimedes learned all these things by experience and got to be an expert in drills. If he once succeeded in making a drill run true and cut the right size, he marked it to show which way it went in the socket and then hid it where he only could find it. This was selfish but justifiable.

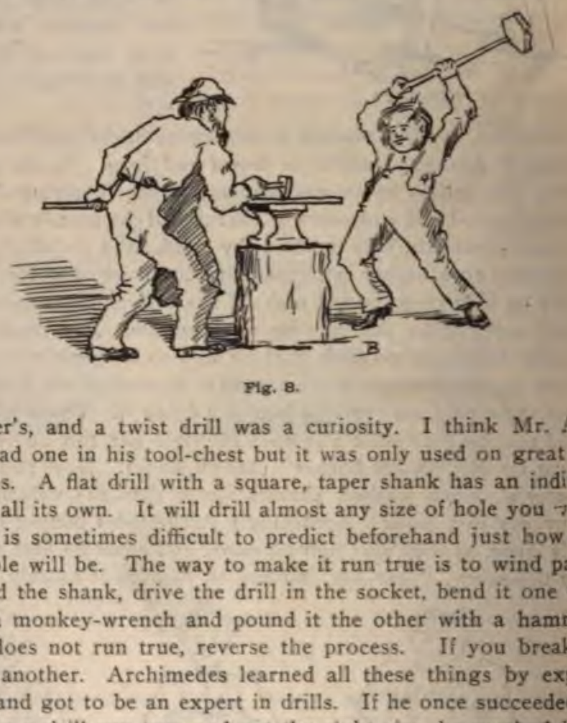

Fig. 8.

Archimedes gradually began to experiment in blacksmithing on his own hook, for Carl was sometimes too busy to sharpen tools. He learned to build a fire in the spare forge and to tell when it had coked enough; to heat the drill in the right place and just enough; when to begin hammering and when to stop; to heat again and dip the point carefully in the water tub for an instant; to scour the flat surface hastily on a sanded board and then watch the colors stealing down from the hot shank, first straw-color, then orange, red and finally purple, until another quick plunge in the water stopped the procession. This is one of the things that few apprentices learn now, in these days of twist drills and grinding machines.

On one occasion Archimedes covered himself with disgrace ame near being banished from the blacksmith shop. Old had a trip-hammer under which he forged most of the work. One day, when the boy was helping Carl, the old asked him to oil up the hammer.

Archimedes got his oil-can the machine shop and pro- d to oil everything about the ine that looked as if it needed ; and finally put on a finish- ouch by oiling the catch-up lly. When Carl started the ier on his next heat, it went cally and seemed to have no of stopping. It pounded the into a shapeless mass, it led the bare dies, and it l be pounding yet if Carl had lipped the belt.

ook the old smith a half hour rd work with emery cloth to he greasy surface off that -up, and it was another half before Archimedes dared to his head.

* * *

## TING THE STRENGTH ꞁF MATERIALS.—3.

### TORSION TESTS.

EDWARD F. MILLER.

il within recent years, com- vely little has been done in lass of testing. Although a general idea of metal can tained from tests made on tension specimens, facts are brought out by torsion tests of which tension tests give no ce. At the Engineering Laboratories of the Massachu- nstitute of Technology, three machines are used for this al testing. Two of these machines, one of 150,000 inch capacity and one of 6,000 inch pounds capacity, were de- at the Institute, the third is an old pattern Riehle machine oo inch pounds capacity.

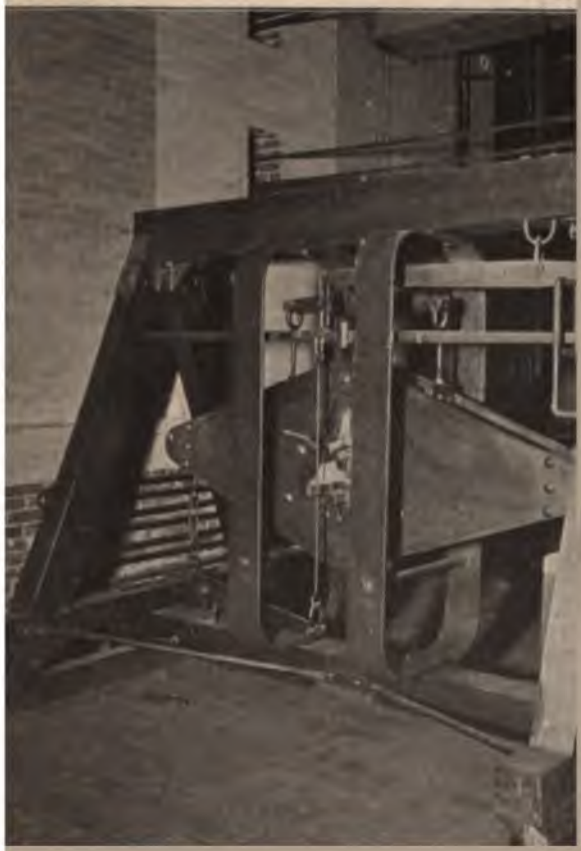

Fig. 2. Torsion Testing Machine, Weighing End.

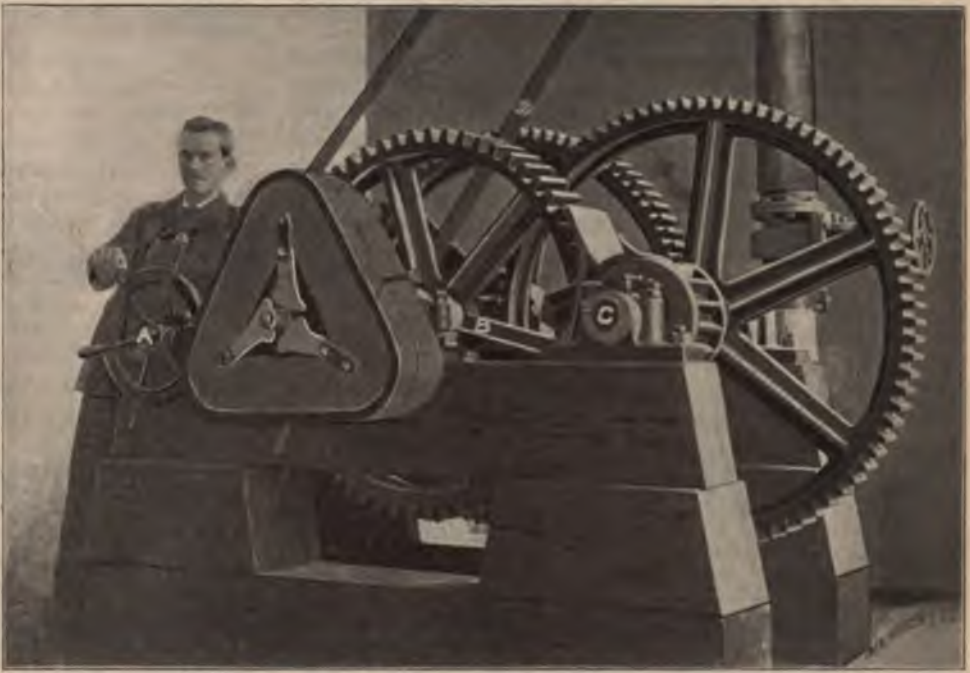

Fig. 1. Torsion Testing Machine, Power End.

Figs. 1 and 2 show the large machine of 150,000 inch pounds capacity. The specimens commonly tested in this machine are from 1½" to 2½" in diameter and of lengths varying from 3 to 12 feet. Fig. 1 represents the power end of the machine. It is driven by a 4" belt running from a countershaft overhead. The gear B is keyed to a 4½" diameter steel shaft, which turns once in about fifteen minutes. The holder is a massive piece of cast iron, re-inforced by two bands of wrought iron 3" wide and 1" thick, shrunk on the outside. The grips are made of cast iron, faced with cast steel which is fluted on the outer surface. As will be seen by reference to the cut, these grips are cams which tend to bite the specimens harder and harder as the twisting head turns to the right. A short piece of a broken specimen of 2" diameter steel is shown in the grips. These grips do not require a shouldered specimen. Steel bars 1½" in diameter containing 1.10 per cent. carbon have been gripped without the least difficulty. A hand wheel is attached to the driving shaft A so that any desired twisting moment may be held on the specimen. This is also used in adjusting the load accurately when the angle of twist of the specimen is being noted.

The weighing end is held in a movable carriage which runs on I beam tracks. A casting, with grips similar to those described above, is attached to a hollow frame made of boiler plate, which is hung from the carriage by an equal arm lever and links, all turning on hardened steel V-shaped knife edges. From a knife edge at each end of this frame a link runs to a lever, one lever being near the top of the carriage and the other near the bottom. The free ends of these levers connect with the weighing beam shown running across the carriage. As the power end holder turns towards the right, the twisting moment, transmitted through the specimen, will tend to rotate the frame so as to cause the right-hand end to go down and the left-hand end to go up. This causes the free end of the weighing beam to lift and the poise weight must be moved to the right to bring this lever level again.

It may be of interest to describe briefly the method by which the angle of twist for a certain twisting moment and the elastic limit in torsion are obtained.

At either end of the specimen, within about 6″ of the grips, a casting carrying a telescope with cross hairs (such as is used on levels) is attached to the specimen by sharp pointed screws. These telescopes are focused on vertical scales fastened to the wall of the room some 40 feet distant. The reading of each scale corresponding with the center of the machine and the distance from the center of the machine to the scales are determined once for all time. The distance of the center of the telescope above the center of the specimen is measured for each test. See Fig. 3.

$$\frac{cb - a}{Y} = \tan A \qquad \frac{c'b - a}{Y} = \tan A'$$

$$\frac{fe - a}{Y} = \tan B \qquad \frac{f'e - a}{Y} = \tan B'$$

$(A - A') - (B - B') =$ angle of twist in distance X.

In this figure T,W is the shaft,T being the twisting end.

Following is a log of a test with the calculation of the results

TORSION TEST.

Specimen. Refined Iron. Date, November 13.

| Twisting Moment. | Scale Readings. | | | | Corrected Mean. | | Angles Corresponding. | | Differences. | | Angle of Twist. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Power End. | | Scale End. | | Power End. | Scale End. | Power End. | Scale End. | Power End. | Scale End. | | |
| | 1 | 2 | 1 | 2 | | | ° ′ ″ | ° ′ ″ | ° ′ ″ | ° ′ ″ | ° ′ ″ | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| 1,800 | 93.23 | 93.23 | 89.91 | 89.92 | 84.08 | 81.86 | 9, 32, 40 | 9, 17, 50 | .. .. .. | .. .. .. | .. .. .. | Specimen fractured 13″ from power end jaw. |
| 3,600 | 84.52 | 84.54 | 84.62 | 84.61 | 75.38 | 76.56 | 8, 34, 20 | 8, 42, 20 | 0, 58, 20 | 0, 35, 30 | 0, 22, 50 | |
| 5,400 | 73.62 | 73.63 | 77.22 | 77.20 | 64.47 | 69.16 | 7, 20, 50 | 7, 52, 30 | 0, 73, 30 | 0, 49, 50 | 0, 23, 40 | |
| 7,200 | 68.83 | 63.84 | 70.90 | 70.90 | 54.68 | 62.85 | 6, 14, 30 | 7, 9, 50 | 0, 66, 20 | 0, 42, 40 | 0, 23, 40 | |
| 9,000 | 55.35 | 55.34 | 65.93 | 65.92 | 46.19 | 57.87 | 5, 16, 40 | 6, 36, 10 | 0, 57, 50 | 0, 33, 40 | 0, 24, 10 | |
| 10,800 | 47.10 | 47.11 | 61.12 | 61.12 | 37.95 | 53.07 | 4, 20, 30 | 6, 3, 30 | 0, 56, 10 | 0, 32, 40 | 0, 23, 30 | |
| 12,600 | 38.71 | 38.72 | 56.21 | 56.22 | 29.56 | 48.16 | 3, 23, 0 | 5, 30, 10 | 0, 57, 30 | 0, 33, 20 | 0, 24, 10 | |
| 12,600 | 91.86 | 91.86 | 89.40 | 89.41 | 82.71 | 81.35 | 9, 23, 30 | 9, 14, 30 | .. .. .. | .. .. .. | .. .. .. | |
| 14,400 | 83.70 | 83.72 | 84.87 | 84.88 | 74.56 | 76.82 | 8, 28, 50 | 8, 44, 10 | 0, 54, 40 | 0, 30, 20 | 0, 24, 20 | |
| 16,200 | 74.70 | 74.70 | 80.09 | 80.07 | 65.55 | 72.03 | 7, 28, 10 | 8, 11, 50 | 1, 0, 40 | 0, 32, 20 | 0, 28, 20 | |
| 18,000 | 64.32 | 64.33 | 75.12 | 75.14 | 55.17 | 67.08 | 6, 17, 50 | 7, 38, 30 | 1, 10, 20 | 0, 33, 20 | 0, 37, 0 | |
| 19,800 | 46.67 | 46.65 | 68.39 | 68.41 | 37.51 | 60.35 | 4, 17, 20 | 6, 53, 0 | 2, 0, 30 | 0, 45, 30 | 1, 15, 0 | |

| | |
|---|---|
| Distance from center of test piece to scale | 500.0″ |
| Reading of level of center of test piece on scale | power end, 3.90″; scale end, 2.80″ |
| Height of center of telescope above center of test piece | 5.25″ |
| Length of specimen between jaws | 61.00″ |
| Dimension of cross section | 1.75 in. dia. |
| Length of specimen between telescopes | 40.00″ |
| Elastic limit in torsion | 14,400 in. lbs. |
| Maximum twisting moment | 53,360 in. lbs. |
| Number of turns of specimen between jaws at fracture | 6.1 |
| Outside fibre stress at elastic limit | 13,700 lbs. per sq. in. |
| Apparent outside fibre stress as calculated from maximum twisting moment | 50,700 lbs. per sq. in. |
| Angle of twist between 1,800 in. lbs. and 10,800 in. lbs | 1° 57′ 10″ |
| Shearing modulus of elasticity between 1,800 in. lbs. and 10,800 in. lbs | 11,470,000 |
| Average number of turns of specimen per foot at fracture | 1.20 |

Columns 2 and 3 and 4 and 5 are readings as taken directly from the scales. Column 6 is obtained by subtracting 3.90 + 5.25 from the mean of columns 2 and 3, and column 7 by subtracting 2.80 + 5.25 from the mean of columns 4 and 5. Column 8 is the angle whose tangent is $\frac{84.08}{500}$ etc.; column 9 is computed in the same way. Columns 10 and 11 are the differences of successive readings in columns 8 and 9. The difference between columns 10 and 11 gives the angle of twist.

The angle of twist increases regularly by about 24 minutes for each successive 1800 inch pounds twisting moment till a load of 14,400 inch pounds is reached. At this load the rate changes. This we call the elastic limit in torsion. The outside fiber stress at this load is calculated from the formula:

$M = \frac{f\,I}{r}$ where M is the twisting moment in inch pounds

I the polar movement of inertia $= \frac{\pi r^4}{2} = \frac{\pi d^4}{32}$

$r =$ radius of the specimen in inches

$f =$ the required stress

$$f = \frac{2M}{\pi r^3} = \frac{2 \times 14{,}400}{3.1416 \left(\frac{1.75}{2}\right)^3} \; 13{,}700 \text{ pounds per square inch}$$

The apparent outside fiber stress as calculated from the maximum twisting moment is:

$$\frac{2 \times 53.360}{3.1416 \left(\frac{1.75}{2}\right)^3} = 50{,}700 \text{ pounds per square inch.}$$

The shearing modulus of elasticity is calculated by the formula:

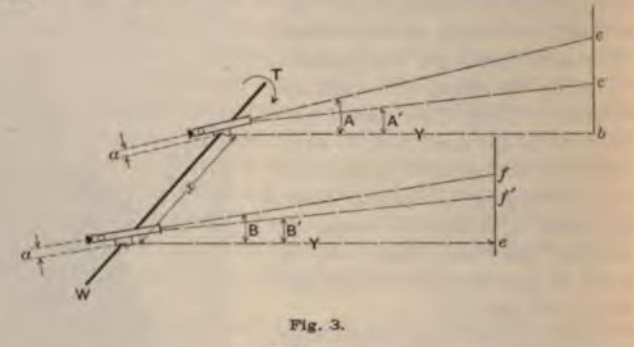

Fig. 3.

$$\text{Shearing modulus} = \frac{MX}{I\,i}.$$

where X is the distance between telescopes, as shown in the sketch. Here X = 40″. I is the polar moment of inertia equal in this case to .9208, i is the circular measure of an angle of twist produced by a certain twisting moment M. By increasing the twisting moment from 1800 to 10800 or by 900 inch pounds the angle of twist increased 1° — 57′ — 10″ or 1.9527°.

The circular measure of an angle of one degree is

$$\frac{3.1416}{180}$$

the circular measure of this angle is therefore

$$\frac{3.1416 \times 1.9527}{180} = 0.0341$$

Substituting numerical values we get:

$$\frac{9000 \times 40}{.9208 \times .0341} = 11{,}470{,}000$$

The shearing modulus of elasticity falls somewhere between 11,000,000 and 12,000,000, having its value equal to about 2-5 of the tensile modulus.

### IMPACT TESTS.

A knowledge of the effects produced on a metal when subjected to a suddenly applied heavy blow or to a series of light blows is much needed. Car axles, crank pins, pump rods, etc., are all subjected to shocks, and many railroad shops have improvised impact testing machines for testing car axles. These machines resemble a small pile driver. Largely on account of the yielding of the supports on which the car axles rest, results from such tests, although of value in comparing metals, are not of much scientific value.

An impact testing machine has recently been added to the U. S. Government testing laboratory at Watertown, Mass., and was designed to assist in the scientific study of metals under different conditions of loading. A knowledge of the effects of repeated shocks on the strength and elasticity of a metal is of especial value in the design of guns, carriages, frames, etc.

### REPEATED STRESS.

A good illustration of a repeated stress is furnished by a length of shafting when running with one or more of its bearings out of line. When a shaft is drawn out of line, either by a belt pull or by the weight of a heavy pulley, stresses similar to those in a beam are set up in the shaft. The fibers in that part of the shaft on the convex side of the curve are in tension and those on the concave side are in compression. At every turn of the shaft these stresses change from tension to compression and ompression to tension. There is also an additional fiber due to whatever twisting moment may be carried through aft. The loading of the tension and of the compression ers of a steel bridge varies as the load on the bridge s. This gives another example of a repeated stress. The on in the steam pressure in a steam boiler subjects the hell to similar conditions. In fact, the cases where this action occurs are too numerous to mention.

e investigations to note the effect of a repeated stress of in range on the life of a specimen have been made. For t thirteen years some work of this nature has been carried he Massachusetts Institute of Technology, but, as a single ten consumes months of time, data does not accumulate y. A paper by Prof. Jerome Sondericker of Massachu- nstitute of Technology, read before the Boston Society of nd printed in The Technology Quarterly, Vol. XII., No. es a summary of a number of his tests on repeated bend- Some results of tests of shafts subjected to combined g and bending were presented, by Prof. Gaetano Lanza, aper read before the A. S. M. E. and printed in Vol. VIII. Society's transactions.

* * *

## HISTORICAL ANECDOTES.

he November, 1899, number of this journal, we gave an ab- of Dr. Coleman Sellers' address at the time of the 75th rsary of the Franklin Institute. This address contained ous anecdotes concerning the early history of the machine ry and as it has recently appeared in full in the January r of the Journal of the Franklin Institute, we quote two m that may be of interest, relative to the development of n methods of planing and boring. Mr. Sellers said:

e planing machine is an invention well within my own ex- ce. In the beginning it had the platen, upon which the is fixed, dragged backwards and forwards by a chain. The laner that William Sellers & Co. purchased and put into as one of this chain pattern, and one was introduced in my 's shops when he undertook to build a locomotive in 1834.

time of the Vienna Exposition, where machine tools from delphia were exhibited, the engineers sent by the British nment to Vienna to note the progress that was being made d the broad feed cut on all the planing machines, lathes ools that came from all parts of America, and remarked it as 'producing good effect,' as 'looking well,' etc., as ere for appearance only, not knowing that it was a prin- hat had been established in America, thoroughly understood ly by the managers of the works, but by workmen all over ountry, and universally adopted as necessary to good work.

hen the early locomotives were built, for example, in the Works, in 1856, the boring of the cylinders was done on a h lathe with a horizontal boring bar, and without any ledge as to the theory of boring in order to produce the esults. It always took two days to bore the cylinder of a otive of the size in use at that time, and I think the largest ers were not over 15 inches in diameter. In Philadelphia, Balwin's had advanced to a very large establishment, they ored the locomotive cylinders in the same way. It was not shortly before the Centennial Exhibition of 1876 that at- n was turned towards the utilization of a theory that had ed in limited practice some years before as to the im- ment in boring metals, the idea being that the quickest and work can be done in boring by making the roughing cut fine feed, removing as much metal as possible by depth of nd making the finishing cut with a very broad feed but light at would let the cutter pass through the hole to be bored ckly as possible so as not to wear the cutting edge in pas-

That principle was first introduced when Mr. Asa Whit- of this city, discovered that chilled cast-iron car wheels be made to compete with the best wrought-iron ones and reater mileage. The problem of boring chilled wheels was by taking advantage of the fine roughing cut and coarse ng feed. Mr. Whitney desired to have wheels made inter- eable in their fit on the standard axles, so that when a wheel tted on an axle at a workshop in Philadelphia, another could be furnished to fit that same axle at any future time st as well as the first one."

"When the late Mr. Hudson had charge of the Rogers Locomotive Works he applied to the firm of William Sellers & Co., to have a special locomotive cylinder boring machine designed and built, saying that he had seen a boring machine designed by Mr. Grant, of the Grant Locomotive Works, capable of boring a 19-inch cylinder in nine hours. The matter was referred to me, and when I came to calculate the theoretical time required for boring a cylinder of the size named, on the supposition that the speed of 16 feet per minute might be used in making the cuts, with a fine feed and a deep cut for the roughing cut, and a shallow cut and a much wider feed for the finishing cut, I found that the estimated time amounted in all to only three hours, and named three and a half hours as not only possible, but what might be guaranteed as the productive output of such a machine. An order was given for this machine, it being understood that it was not only to bore the cylinders, but to counterbore the ends for the clearance of the piston, to cut off the sinking head and face up the flanges at each end of the cylinder. When completed, the first test was made with a 19-inch cylinder of hard close metal. This was bored in three hours and twenty minutes, exclusive of the time of setting the cylinder, which was not much on account of the peculiar arrangement of the machine, and the facility with which the cylinder could be put in place for boring. In this case the cylinder stood still, while the boring bar travelled lengthwise, carrying the cutter head with it, and upon the two face plates of the driving heads of the machine were arranged automatic slide rests that faced off the flanges."

* * *

## A. S. M. E. ABROAD.

The plan that was talked of last winter of chartering a special steamer for the use of the members of the American Society of Mechanical Engineers who are to go to the Paris Exposition, has failed because of the inability of many of the members to state at so early a date just when they expected to be able to sail and even whether they would be able to attend at all. Circulars have, therefore, been sent out recently to the different members, asking when they expect to leave for the Exposition, if at all, and it is hoped that a considerable number will be able to congregate at London on or about July 5, on which date the Institution of Civil Engineers of Great Britain holds a reception, to which American Engineers are invited as guests. During the days that precede and follow—perhaps between July 2 and 9—the American Engineers are to be the recipients of courtesies from the English hosts, in the way of visits and excursions, which will be arranged for, and it is not unlikely that on the Sunday, July 8, there will be services of special interest either at Westminster or elsewhere, which the engineers would enjoy the opportunity to attend. Probably on the Monday or Tuesday following, July 9 or 10, the party will leave London by rail, in special trains, en route for Paris.

For those who may find it necessary to sail earlier, the Institution of Mechanical Engineers of Great Britain arranges to hold its London Meeting during the second week of June, which, it will be observed, is some weeks earlier than the date fixed for the other Society. The Mechanical Engineers of Great Britain invite the American Engineers to take part in their meeting and excursions, receptions, etc., and the date of the gatherings is sufficiently far removed to prevent conflict on the one hand, while leaving a space between the two meetings for the general opportunities of an English visit for those who may be able to spend time enough in London to avail themselves of both opportunities.

It is also probable that after the trip to Paris, arrangements will be made for the further entertainment of American Engineers by important bodies in Berlin. It is premature as yet to give dates as to the purposes of the engineering societies in either Paris or in Berlin.

* * *

It is estimated that one square foot of uncovered steam pipe will radiate 10 thermal units per minute, with steam at 100 pounds pressure. This is equivalent to the condensation of about seven pounds of steam at this pressure per square foot of pipe in a day of 10 hours.

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France.—Paris: Boyveau & Chevillet, 22 Rue de la Banque; L. Roffo, 58 Boulevarde Richard Lenoir; Fenwick Freres & Co., 21 Rue Martel.
Germany.—Berlin: F. A. Brockhaus, 14 Oberwallstrasse, W.—Garvin Machine Co., 17 Burgstrasse, C.—Schuchardt & Schutte, 59-61 Spandauerstrasse, C.—Dusseldorf: de Fries & Co., Actien, Gesellschaft.—M. Koyemann.—Mulhouse: H. Stuckelberger.
Hawaiian Islands.—Honolulu: Hawaiian News Co.
Holland.—Amsterdam: Peck & Co.—Rotterdam: H. A. Kramer & Son.
India.—Calcutta: Thacker, Spink & Co.
Italy.—Rome: Giorgi, Arabia & Co.
Japan.—Nagasaki: Lake & Co. Yokohama: Andrews & George.
Java.—Tegal: W. J. Amons.
Mexico.—City of Mexico: F. P. Hoeck.
New Zealand.—Aukland: J. Flynn.
Norway.—Christiania: C. S. Christensen.
Russia.—Moscow: J. Block & Co.; Mellier & Co. St. Petersburg: Wossidlo & Co.; F. de Szczeyanski; Carl Ricker.
Spain.—Barcelona: Librairie A. Verdaguer. Madrid: Librairie Guttenberg.
Sweden.—Stockholm: B. A. Hjorth & Co.—Zacco, Bruhn & Co.
Switzerland—Zurich: Mayer & Zeller.
Turkey.—Constantinople: V. L. Levy.
United Kingdom.—Sampson Low, Marston & Co., St. Dunston's House, Fleet Street, London, E. C.

## APRIL, 1900.

## CIRCULATION STATEMENT.

The regular edition of Machinery for April is 21,500 copies. American Machinery is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. Except on the special quarterly numbers, no papers are sent free other than to advertisers, exchanges and circulation agents.

The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

| | |
|---|---|
| The Iron Age, about | 7,000 |
| The American Machinist, about | 12,000 |
| Machinery | 21,500 |

It can be stated as a general principle that whatever reduces the time and cost of fitting the parts of a machine together and erecting the same, is worth considering from the standpoint of economical production. One of the large users of gear wheels for heavy and rough work formerly employed gears with cast teeth, because, for the class of work turned out, they gave just as good results, and were fully as strong as wheels with cut teeth. Now, however, all the gear wheels made by this firm have cut teeth, and the reason for making the change was purely to save the excessive cost of fitting and erecting incident to the cast teeth. While a good mechanic and a helper had been known to take three days to fit two gears, with their shafts and their bearings, the same work where cut gears were employed scarcely required more than the same number of hours. Moreover, it is a question whether the cost of the cut gears is after all much greater than of the cast ones. The gears are cut by automatic machinery, improved grinding machines reduce the cost of keeping the cutters in shape and the wheel rims, which would not be finished if the teeth were cast, are turned and faced in this instance simultaneously with the chucking. The question of the expense of the cut gears, therefore, sifts down practically to a consideration of the interest on the cost of the machines used in making them.

## LABORATORY WORK.

Prof. Breckenridge, of the University of Illinois, recently addressed the St. Louis Railway Club upon the subject of Technical education and gave the following reasons for the value of laboratory practice to the student of engineering:

(a) It teaches him to locate wastes (of material, of fuel, of power).
(b) It teaches systematic methods of investigation.
(c) It exercises his ability to make a clear written statement of the results obtained.
(d) It familiarizes him with the various types of commercial appliances used in practice.
(e) It gives him confidence in his own ability to do things.
(f) It fixes in his mind the useful constants, methods and records of engineering practice.

All will agree, we think, that these are good and sufficient reasons why laboratory practice should form a part of the instruction in every well-appointed course of instruction in mechanical engineering. It may justly be asked, however, whether the amount of time devoted to this branch of instruction and the degree of importance attached to it are not sometimes overestimated.

There can be no doubt that the laboratory idea is very popular, not only with the professors themselves and their students, but with practical men outside who are engaged in commercial work. In the early days of technical education there were no laboratories at all in any department. Chemistry, even, was taught from the text-book instead of by actual experience with chemical reactions in the laboratory. Then came chemical and physical laboratories and these were so successful that engineering, applied mechanics, metallurgical and other laboratories, devoted to the various engineering professions, followed as a natural sequence. They have all been successful, and have improved the different engineering courses very greatly, but in spite of their success it does not follow that too much laboratory is a good thing. A distinction should be drawn between the objects of the chemical and physical laboratories and, for example, the laboratory of mechanical engineering. The chemist spends his life, so to speak, in his laboratory, and so does the physicist, but the amount of time devoted to testing materials and appliances by the mechanical engineer is comparatively small. In fact, it is safe to say that nine out of ten of the graduates of technical schools never have any testing to do at all and of those that do, probably not one in ten has to do more than to conduct engine and boiler trials, or to make simple commercial tests that require but little special training.

It seems, therefore, to be an open question whether there is not danger of carrying instruction in laboratory practice to an extreme. Every student should be drilled thoroughly in engine and boiler testing and in making tests of the apparatus used and of the coal and gases, such as have to be made in any expert test of a power plant. He should also be grounded in the general principles of some few other tests and it might assist him in his future work if complete notes were furnished him giving directions for conducting a wide variety of other tests. Beyond this, however, would it not be better to make extended laboratory work an option, to be taken or not as elected by the student? Take, for example, the case of a student who expects to enter into manufacturing, and whose chief work will be in connection with the design of machinery and its construction in the shop. More extended courses in machine design and shop management than are ordinarily given would benefit him directly and to a greater extent than laboratory work. Many of the colleges offer options to the students and give them a wide choice in their courses of study; but as far as we know an equal amount of laboratory work is required of each and the amount of time taken for this is generally rather extensive. If this time were reduced for the regular courses and devoted to other subjects and then an option of more laboratory work offered, we think the average student would be better suited. There is too much laboratory work done under the guise of "practical work" when, as a matter of fact, it is not practical work at all in the sense of being in the line of work that is to be done by the student after graduation.

* * *

Our well-known contributor, Prof. W. H. Van Dervoort, is now in Paris on a brief business trip, and until his return, his series upon machine tools, that has been running through the last few numbers of the paper, will have to be interrupted.

## HOW AND WHY.

**PARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.**

**ıll details and name and address. The latter are for our own convenience and will not be published.**

-H. B.: A friend and I have had an argument with regard ;ear problem, which we would like to submit to you for nent. The question is this: Suppose we take two gear s, each having 24 teeth, and allow one wheel to remain ıary while the other is rotated about it, the teeth being in :t all the time. Will the rotating gear have made a revo- about its own axis when it has turned half way around the ıference of the stationary gear?

-In the accompanying sketches, let us suppose B to be the ıary gear, C the one that turns around it and A the arm cting the two gears, in order to keep them in contact. We rst assume that both gears and the arm are locked fast to- and that they are all turned as one piece about the axis of :-half turn, to the position shown in Fig. 2. Each part,

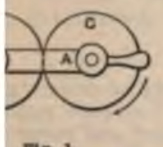

Fig. 1.

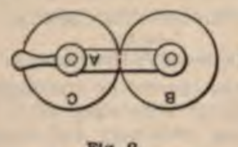

Fig. 2.

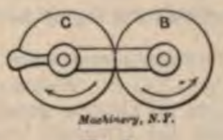

Fig. 3.

C, will then have made ½ turn about the axis of B. Now, ıve done just what we wished to do with the arm A, y, turned it half way round, but have at the same time l B, which was to have remained stationary. Hence, we ɔw hold the arm stationary and turn B back to its original ɔn, as shown in Fig. 3. This operation will cause C to another half turn, bringing it to its original position, ex- hat it is at the left of B instead of at the right, as in Fig. 1. ıve thus completed the desired operation, but have done it ɔ separate movements for the sake of analysis. It will be hat in the process C has made one complete turn, but one- f this turn was made about the axis of B and the other half its own axis. Hence the answer to your question is that the gear makes one complete turn in passing half way d the stationary gear, it makes but one-half turn on its xis.

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-Subscriber: In cutting threads on taper taps or plugs, l the tool be set square with the face of the work or square he axis of the piece? 2. How do tool makers cut threads :ces of tool steel that are to be hardened and obtain the :t number of threads per inch after hardening? The steel e sometimes contracts 1/24th of an inch in hardening and ıuently there are more threads in a certain number of than there should be.

-Set the tool square with the axis. See answer to question the February number. 2. Your difficulty is one that every ıeets with and that there is no good way of remedying, so we know. That the tap manufacturers do not remedy it in commercial product you are probably aware of, as the in pitch can frequently be detected by the aid of a com- ıcale. Something may be gained by annealing the steel ɔr twice, taking one or more cuts between each annealing, peating the process for the last time before the final cut is upon the thread. The idea is to relieve the initial stresses surface of the metal as much as possible, which tend to or twist the piece, but this can have but little effect upon its ıction as a whole. Harden in pure water, immersing the ıd first.

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-J.A.C.: Will you tell me the proper way to harden a ball hammer made from Jessop's steel so that the center will :d to prevent scratching.

-To harden a hammer so that the center will hold a polish, be necessary to harden it all over, a method which is not y followed or recommended, as there is considerable r of cracking through the eye. The hardening operation t be carefully performed, the hammer being uniformly l and then plunged into clean cold water. When cold it l be slightly polished so that the changes of color can be ed when the temper may be drawn by suspending the ham- n a piece of red hot iron thrust through the eye. In this way the eye part will be drawn to a low temper before much change in the face or ball of the hammer can be seen. Thus you may be able to satisfactorily temper a light hand hammer, but it would probably not work well with the heavier ones. To harden a heavy hammer so that it will fulfill the requirements, you may be able to do it satisfactorily by hardening all over as described and drawing the eye part down to a purple. Then by carefully heating the face without raising the temperature of the eye, the face may be hardened and drawn at one operation. The ball pene may also be hardened and drawn to the proper temper in the same way. The proper color for a hammer face is commonly taken to be a light straw or just the first changes in color. A full straw color will usually give satisfactory results or even somewhat softer. We would not advise hardening a hammer all over as described, but if it be done, it should be given to an expert, who not only understands such work, but who is also an adept in the necessary manipulation—not a small part by any means.

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46.—We have received two questions which we will submit to our subscribers for replies. The first is, "Where can I obtain fusible solder? I wish to solder some babbitt letters to cast iron. What kind of flux would you advise?" The second one is "Please give me the receipt for a solution for coloring bright brass a dull, fast black and the method for applying it."

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47.—E. G. K.: In page 186 of the February number, Mr. W. H. Van Dervoort describes a method of boring a taper hole in a piece clamped to the face plate of the lathe, by means of a bar placed between the centers, the tail center being set over sufficiently to give the correct taper. Please explain how to calculate the amount to set over the tail center in order to bore any required taper.

A.—Prof. Van Dervoort shows three arrangements of bars for boring tapers, but with all of them the principle is the same. Whenever one end of the bar is on one center and the other end is off-set, the amount of the off-set should be enough to give the bar one-half the inclination per foot that the hole is tapered per foot. For example, if the hole were tapered one inch per foot, the bar should have an inclination of ½ inch per foot. If the bar were 2½ feet long, it would have to be off-set 2½ times ½, = 1¼ inches; if it were 17 inches long we should have, 17 inches = 1 foot 5 inches, = 1 5/12 ft. Hence, 1 5/12 × ½ = ½ + 5-24 = 17-24 = .708 inch.

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48.—O.F.: If a stone or iron ball were dropped into the water, would it sink to the bottom, regardless of the depth, or is there a depth at which it would remain suspended?

A.—Suppose there were such a depth; for example, at the center of the Pacific Ocean. It is clear that all the earth and stones at the bottom of the ocean would then rise to this point and float about, forming a floating submarine island, and the ocean would be literally without bottom. The absurdity of such a condition makes it evident that the condition mentioned in your question could not exist. It is possible that some substance, having a specific gravity but slightly greater than that of water, might sink to a point where the water would be sufficiently dense, owing to the pressure of the water above, to have a specific gravity equal to that of the substance in question. If this were the case, the substance would float at this point. It is estimated that a cubic foot of water would increase in weight only about ½ pound at a depth of a mile, so nearly imcompressible is it. Assuming the weight of water under atmospheric pressure, only, to be 62.4 pounds per cubic foot, then, according to this, a body weighing 62.9 pounds and displacing a volume of one cubic foot would float, or remain suspended, at a depth of one mile. However, it would be nearly impossible to find such a substance, which at the same time should be incompressible, so that at the depth of one mile it would still have one cubic foot volume. If the body were compressed as much or more than the water, as is probable, it would continue to sink regardless of the depth, because its weight per cubic foot would continue to be greater than the water.

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49.—G.S.: Please give me information in regard to the size that I should have to turn an axle for a street car wheel so that there would be a correct allowance for pressing together. The wheels have a 2⅞ inch hole. How many tons pressure would be required to press the wheel on the axle and would it be necessary to taper the axle in order to start it? We have never done any work of this description, but want to begin to make street car repairs.

A.—In the data sheet issued with the September, 1898, number of MACHINERY, you will find a diagram showing how much to allow for force fits. For an axle 2⅞ inches in diameter this diagram calls for about .005 inch for forcing. If the hole is smooth and the axle nicely finished, this will be enough, but if the work is rough, as will probably be the case, you will have to allow a little more, perhaps .008 inch. If the wheel presses on with 25 to 30 tons pressure it will be sufficient. For simply pressing the wheels on their axles, a 50-ton press will be ample, but when it comes to removing wheels that have been in service for some time, the pressure required may be double what is required to put the wheel on and we should recommend a 100-ton press, if possible, and certainly not less than a 75-ton press.

50.—E.R.W.: Please explain how the reading is taken from an ordinary micrometer caliper and also how is a sliding jaw vernier caliper read?

A.—The principle on which the ordinary micrometer operates is very simple, being usually an accurately cut screw of 40 threads to the inch to which is attached a barrel that moves over a graduated line. The graduations correspond to the pitch of the screw, so they are 1-40 of an inch apart. The barrel is graduated on its circumference into 25 parts, so it is evident that when the barrel is turned through one graduation, the measuring points are approached or separated by 1-25 of 1-40" or 1-1,000 of an inch. If the barrel should be turned so that seven graduations on the longitudinal line are exposed and the ninth graduation on the circumference of the barrel coincides with the line, the reading would be 7-40 + 9-1,000 or 184-1,000, since 7-40 = 7 × 25 or 175-1,000 and 9-1,000 being added gives 184-1,000 or .184". The reading of the Starrett micrometer barrel shown in the accompanying cut is slightly less than .100" since a little less than four divisions of 1-40" each are exposed. To illustrate the reading of the sliding jaw vernier caliper, we have reproduced the cut that appears in the Brown & Sharpe catalogue together with the accompanying description:

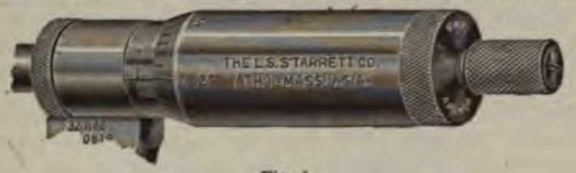


Fig. 1.

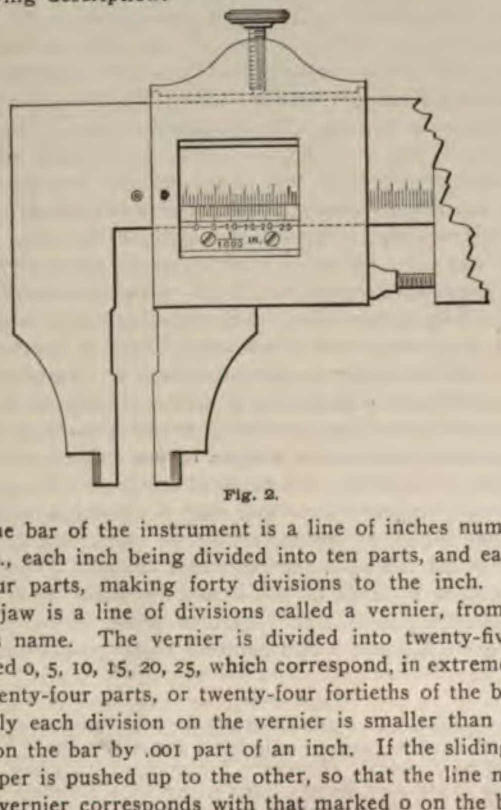


Fig. 2.

On the bar of the instrument is a line of inches numbered 0, 1, 2, etc., each inch being divided into ten parts, and each tenth into four parts, making forty divisions to the inch. On the sliding jaw is a line of divisions called a vernier, from the inventor's name. The vernier is divided into twenty-five parts, numbered 0, 5, 10, 15, 20, 25, which correspond, in extreme length, with twenty-four parts, or twenty-four fortieths of the bar; consequently each division on the vernier is smaller than each division on the bar by .001 part of an inch. If the sliding jaw of the caliper is pushed up to the other, so that the line marked 0 on the vernier corresponds with that marked 0 on the bar, then the two next lines to the right will differ from each other by .001 of an inch, and so the difference will continue to increase, .001 of an inch for each division, till they again correspond at the line marked 25 on the vernier. To read the distance the caliper may be open, commence by noticing how many inches, tenths, and parts of tenths, the zero point on the vernier has been moved from the zero point on the bar. Now count upon the vernier the number of divisions, until one is found which coincides with one on the bar, which will be the number of thousandths to be added to the distance read off on the bar. The best way of expressing the value of the divisions on the bar is to call the tenths one-hundred thousandths (.100), and the fourths of tenths, or fortieths, twenty-five thousandths (.025). Referring to the cut shown in Fig. 2, it will be seen that the jaw is open two-tenths and three-quarters, which is equal to two hundred and seventy-five thousandths (.275). Now suppose the vernier was moved to the right so that the tenth division should coincide with the next one on the scale, this will make ten-thousandths (.010) more to be added to two hundred and seventy-five thousandths (.275), making the jaws to be open two hundred and eighty-five thousandths (.285).

*The following questions were answered by Wm. Baxter, Jr.*

51.—J.O.P. Would the current be alternating or direct, taken from an electric generator consisting of a four pole rotating field, the armature being stationary and wound and connected the same as a Gramme ring armature? If alternating, what would be the winding and connections of the armature to obtain a direct current?

A.—If the armature were wound and connected with a commutator in the same way as in an ordinary generator, two alternating currents could be derived if four stationary brushes were located so as to press against the commutator surface ninety degrees apart. To obtain these two currents it would be necessary to connect the line wires to adjoining brushes.

If the opposite brushes were connected together by short wires and the line wires were connected with these, so that each line wire would be connected with the diametrically opposite brushes, one alternating current would be obtained. If the brushes be attached to the field, so as to rotate with it, the current will be direct, and one or two currents can be obtained by connecting the brushes with the line wires in the same way as with the stationary brushes.

52.—H.C.M. Will you kindly tell me how I can arrange an electrical gage on a water tank, by means of one wire, so that gage will indicate the depth of water in the tank, in feet at pump house, and at same time sound a magnet bell. It is desired also that the same device shall indicate depth of water as it recedes. The tank is 1,000 yards from the pump house.

A.—There are several ways in which such a gage can be arranged, but a full explanation would be too lengthy for this department. The most we can do is to outline the general principle. About the simplest way would be to arrange a float so that it would make electrical connection for different depths of water, one, two, three feet, etc., each connection placing in series in the line circuit a number of battery cells proportional to the number of feet of water. For example at one foot depth, one cell would be connected; at two feet, two cells in series, and for four feet, four cells in series, and so on for greater depths. At the receiving end, magnets would be arranged to ring bells and also to throw into view discs numbered to correspond with the depth of water in the tank. The magnets actuating these discs and bells would be adjusted so as to have sufficient force to act when the current was supplied by the proper number of cells but not with a smaller number. Thus if at four feet depth four cells were connected with the line, the magnet actuating disc four would be energized sufficiently to throw the disc, and so would all the magnets for lower numbers, that is, for 1, 2 and 3; but the magnet actuating disc 5, would not move.

The foregoing may help you to devise an arrangement that will work, but unless you are fairly well posted in electrical wiring, and the operation of magnets, we would not advise you to try it because to operate, the various parts of the system must be properly adjusted, and such adjustment cannot be obtained by any one who has not had some experience in such matters. Any electrical bell hanger, who has installed hotel annunciators, ought to be able to work out a simple arrangement that will accomplish the object in a satisfactory manner.

## GAS ENGINE DESIGN.—5.

### PISTONS, CONNECTING-RODS AND CRANKS.

E. W. ROBERTS.

ving the question of valves and their accessories until we finished with the major parts of the engine, the proportions piston will now be considered. With a few unimportant ex-ns, all gas engines employ a trunk piston with one end of onnecting rod pivoted on a pin fastened in the piston itself. is done for the reason that great difficulty has been exper-d with keeping the temperature of a piston rod at a point will permit of its use without cutting. Several engines been designed that employ a piston-rod successfully but by no means represent general practice in the gas engine try.

ile the proportion between the length of the piston and the ter of the cylinder, varies with the designer and is quite fre-ly the outcome of guess-work—popularly termed "judg-"—average practice appears to be to make the length of the one-third greater than the diameter, although a case is ionally found in which the length is twice the diameter of ylinder. Mr. Wm. Norris, an English writer on the sub-gives as a rule for the length of the piston, that the maxi-pressure per square inch of projected area should not, in ase, exceed 20 pounds. In order to find what this pressure writer will follow the graphical method suggested by Mr. is, and apply it to the indicator diagram Fig. 11, article 2. g the connecting rod as twice the stroke of the engine, the ure upon the piston per square inch of cylinder area is as shown in Fig. 20. First lay out the diagram D, and istance AB—the length of the connecting rod—(twice the e in this case); then the distance BC = ½ the stroke. ribe the quadrant B E with the radius equal to C B. The arc be continued to a half circle, if desired, to show the pres-on the piston throughout the stroke, but it is unnecessary so for this case, as the maximum pressure in this form of am will be found on the first half of the stroke. Erect the al lines a, c, d, e as close together as appears to be re-d and, from their intersections with the atmosphere line strike arcs cutting the quadrant B E with a radius equal to ngth of the connecting rod. The method of finding the ures at the various points of the stroke between the piston he cylinder may be shown by a single example as when iston is at the point a. To find the pressure at point a lay e distance a b along the line X Y, which will locate the b'; from b' erect the perpendicular b'm, meeting the line m. The distance b'm is that representing the side pressure piston on the cylinder wall, computed from the pressure quare inch as shown by the indicator diagram. The total hrust of the piston would therefore be b'm X the area of iston.

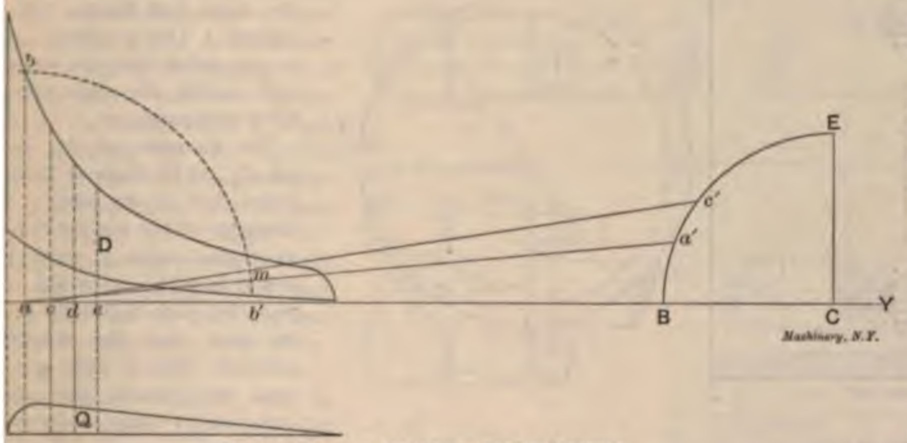


Fig. 20. Diagram for Finding Piston Pressure.

order to simplify the calculation of the length of the piston, riter has derived a formula in the following manner:

D = the diameter of the cylinder, in inches,
L = the length of the stroke, in inches,
maximum side pressure of the piston corresponding to the pressure upon one square inch of the piston area, (= value of line b'm in Fig. 20.)

Since the area of the piston is equal $\frac{\pi D^2}{4}$, it will then be evident from the previous paragraph that the total side pressure of the piston $= \frac{p \pi D^2}{4}$.

But the projected area of the piston is equal to DL and since the pressure per square inch of this projected area should not exceed 20 pounds, another expression for the total side pressure is 20DL. Placing these two expressions equal,

$$20\,D\,L = \frac{p \pi D^2}{4}\,;\ \text{or } L = \frac{p \pi D}{80} \qquad (19)$$

In Fig. 20 the highest pressure for p is found to be 32 pounds and substituting this pressure for p in formula 19, the equation becomes $L = \frac{32 \times 3.1416 \times D}{80}$; $L = 1.26\ D$ nearly, the result showing that the ratio L = 1 1-3 D is ample for these conditions which in practice are close to the average limit.

An example of a class of piston that is in use in many gas engines is shown in Fig. 21. The various proportions of the piston are based upon the diameter of the cylinder and are as follows:

A = .08D
B = .07 D
C = ½ B = .035 D.
E = .035 D + ⅛"
F = H = G = .04 D.
M = N = 2/3 D or ½ the length I
I = 1 1/3 D

The diameter R of the piston ring is usually from 1 per cent. to 1.5 greater than the diameter of the cylinder. For a six-inch piston this would give as the diameter of the ring 6 1-16' to 6 3-32". The thickness of the ring at S, its widest portion, should be about 1/16" greater than its width, or .035 D + 1-16", and the thickness at T should be about 2/3 S. The writer was once asked by the superintendent of a gas engine factory to calculate the shape of cross-section for a ring of this sort which would be of equal strength throughout, the width of the ring being necessarily the same at all points. Referring to any work on the subject of mechanics, it will be found that such a beam, if rigidly supported at the center, should have straight sides which taper to nothing at the outer end. It would, of course, be unpractical to make the ring of such a form and the writer was compelled to resort to practical experience in order to decide upon the best form.

In turning up a packing ring for a gas engine, the opening should be cut before the outside of the ring is finished to size. The ring should then be clamped in a jig with the ends sprung together. While in this position the ring should be turned to the same diameter as the bore of the cylinder. Only in this manner can a tight ring be secured that will successfully withstand the high pressures now in vogue in gas engine practice. The number of rings that should be used in a gas engine cylinder is a subject of some difference of opinion. It is not customary to use less than three rings in the smallest engines, and usually the number of rings is increased to four for sizes above 8" diameter. One of these rings is quite often placed as shown by the dotted lines at X, many gas engine builders claiming that it relieves the piston of pressure on the cylinder. As the piston is not in any case supported by the rings, the writer fails to see the force of such an argument, and believes that a ring in this position is of doubtful utility. Quite often five rings are found in pistons above 12" diameter. With the proportions given in Fig. 21, it would be necessary to move the piston-pin in case all five rings were placed at the head end of the piston.

In small pistons the web G is usually omitted and the piston constructed as shown by the dotted line. The extra thickness of metal at A, is for the purpose of preventing the first ring from becoming over-heated, and, in some engines, a wrought iron plate is bolted to the head of the piston with an asbestos pad between the plate and the piston. Another attachment to the cylinder head is what is called a compression plate and is bolted to the piston head in case the engine is to run at high altitudes, where the pressure of the atmosphere is considerably below that found at the sea-level. It is best to attach these plates to a piston for altitudes exceeding 5,000 feet. It is as well to caution the designer against permitting projections of any sort upon the head of the piston or at any point within the compression space that is not subject to the cooling effect of the water-jacket. It is not generally known, but it is nevertheless true that considerable trouble is experienced with engines in which this precaution has been neglected. Where fuels having a low ignition point are employed, such as gases rich in hydrogen, gasoline and acetylene, this precaution should be doubled. Either the projections themselves, or deposits of carbon which collect upon them, become heated to a comparatively high temperature, with the result that premature ignition takes place, sometimes as early as during the suction stroke.

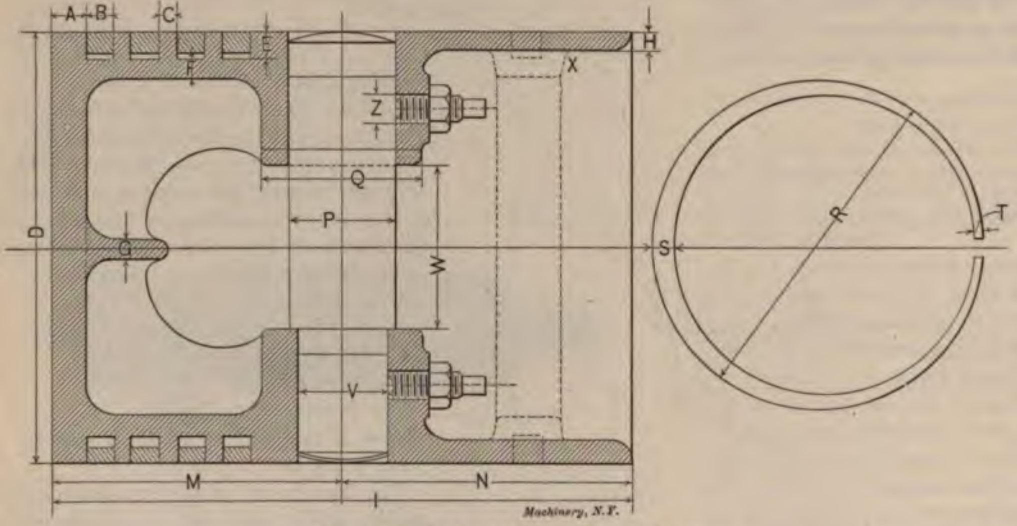


Fig. 21. Design and Proportions for Piston.

The diameter and length of the piston-pin should be such that the total mean pressure upon the pin should not exceed 750 pounds per square inch of projected area. It is customary to make the length W the same as that of the crank pin in order that the brasses may be the more readily lined up. Considering therefore the length W as already determined, the diameter P may be found by means of the following formula:

Letting A = the area of the piston,
p = the mean effective pressure.

$$P = \frac{A\,p}{750 \times W} \qquad (20)$$

The metal at the outside of the piston assists in supporting the pin so the dimension Q may be made 1.5 P. A good proportion for the set screw Z is to make its diameter ¼ that of P. The diameter V should be enough less than that of the pin to make a good shoulder, the proportion shown in the figure being V = .8P.

With the exception of the smaller sizes, three horsepower and below, nearly all American-made gas engines are fitted with slab cranks. The general formulas for the diameter of a crankshaft are those given below:

Let S = the diameter of the crankshaft,
L = the length of the stroke in inches,
D = the diameter of the cylinder,
m = the maximum pressure within the cylinder,

$$S = .056\sqrt[3]{m\,L\,D^2} \text{ for wrought iron.} \qquad (21a)$$

$$S = .052\sqrt[3]{m\,L\,D^2} \text{ for steel.} \qquad (21b)$$

In case the length of the stroke is 1½ times the diameter of the cylinder, these formulas may be further simplified to:

$$S = .064\,D\sqrt[3]{m} \text{ for wrought iron} \qquad (21c)$$

$$S = .059\,D\sqrt[3]{m} \text{ for steel.} \qquad (21d)$$

In order to illustrate the application of these formulas, suppose it is necessary to compute the diameter of the crankshaft for an engine 16 × 24 and with a maximum pressure within the cylinder of 300 pounds per square inch. In this case the length of the stroke is 1½ times the diameter of the cylinder and formula 21d may be used if the shaft is to be made of steel, which is undoubtedly the best material. Substituting in the formula it becomes $S = .059 \times 16\sqrt[3]{300}$. The cube root of 300 may be found from a table of roots and is 6.6943, the first two figures of which are sufficient for the purpose, and .059 × 16 × 6.69 = 6.3, say a 6¼ shaft. For wrought iron, the shaft should be .064 × 16 × 6.69 = 6.88, say a 6⅞ shaft.

Take the same size cylinder but with a stroke of 20", and for steel it becomes necessary to employ formula 21b giving the equation $S = .052\sqrt[3]{300 \times 20 \times 16^2}$, the product under the radical sign becomes 300 × 20 × 256 = 1,536,000, and the cube root of 1,536,000 is 115.38, .052 × 115.36 = 6. For wrought iron the shaft should be .056 × 115.36 = 6.45, say, a 6½ inch shaft. In either of these computations the decimal .36 may be dropped and the three first figures 115 employed. The reader is asked to remember that the writer is still using the slide-rule for these computations.

The diameter of the crank-pin should be made at least 1⅛ times that of the shaft. The diameter of the pin for the 16 x 24 engine using a steel shaft would be 6 × 1.125 = 6¾. The projected area of the pin should be such that the maximum pressure upon it does not exceed 400 pounds per square inch, and in order to determine the length of the pin, the diameter being known, employ the following formula:

Let q = the diameter of the pin,
f = the length of the pin;
A and p as in formula 20;

$$\text{Then } f = \frac{A\,p}{400\,q} \qquad (22)$$

In this example just cited, to find the length of the pin, the proper substitution in the formula, calling the M.E.P. 75 pounds, gives

$$f = \frac{201 \times 75}{400 \times 6.75} = 5.64 \text{ say } 5⅝.$$

Continuing with the same engine compute the diameter of the piston pin by means of formula 20. The length of the pin will be taken as 5⅝, or the same as that of the crankpin. Substituting in the formula:

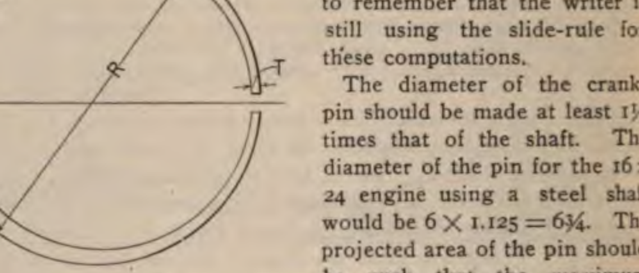


Fig. 22. Proportions of Crank and Crank-pin.

$$P = \frac{201 \times 75}{750 \times 5.625} = 3.6 \text{ say } 3⅝'' \text{ diameter for the piston pin.}$$

The reason for allowing so much more pressure upon the piston pin is that it is not subjected to the amount of turning movement that occurs with the crankpin.

So much difference of opinion exists regarding the amount of pressure to allow on the crankpin journals, and the figures for this purpose are so wide apart, that the writer has decided to give a proportion for the length of the crankshaft journal. The e practice in the United States appears to be, to make gth of the bearing 2 to 2.5 times the diameter of the haft, denoted by l in the Fig. 22. The remaining propor- re as follows:

$t = .8s$ (23)
$w = 1.4s$ (24)
$z = .2s$ (25)

is often the case, a gear is placed between the bearing e crankweb, a space must be allowed for it. It is quite ient when erecting the engine, if the shaft be turned about rger where the gear is placed than for the remainder of gth, in order that the gear may be slipped over the shaft reaches its position and then be put in place with a snug uite often the crankpin is oiled by means of an oil-hole through the center of the pin and out to the surface. A ube is used to connect this hole with a collar on the shaft e oil is distributed by means of the centrifugal force.

connecting rod of a gas engine is not the least important , and many an engine has been hopelessly wrecked by an gned or defective connecting The writer remembers a case nt where a fifty horse-power returned to the factory in a able shape, the rod having in the middle with a clean e, denoting that the material t to blame. The designer con- in a shamefaced sort of way, e "kinder didn't figger it." r investigation proved that the had been designed and built te, and that the rod used was lly intended for a forty horse- engine.

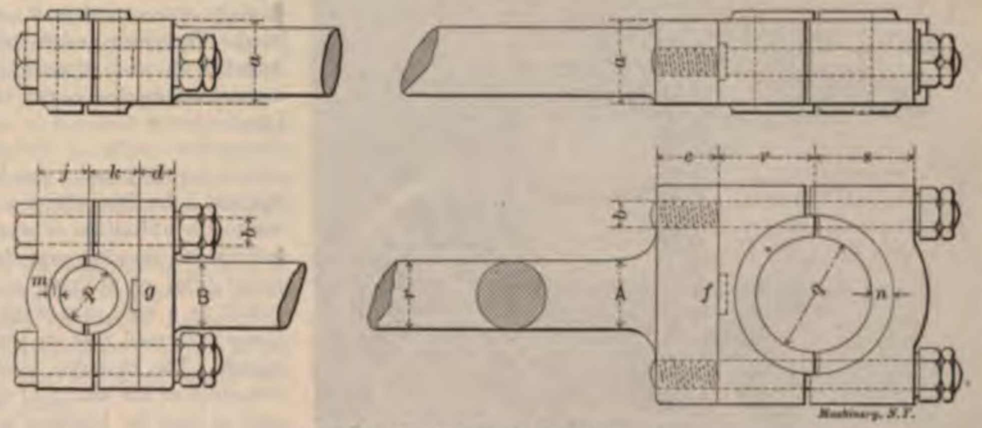


Fig. 23. Marine Type of Connecting-rod.

following formula will be to give ample dimensions for ting rods made from mild The mean diameter of the rod is taken as half the sum diameters of the two ends:

r = the mean diameter of the rod.
) = the diameter of the cylinder.
l = the length of the rod between the centers of the pins in inches.
a = the maximum pressure in the cylinder.

$r = .035\sqrt{D\,l\,\sqrt{m}}$ (26)

his formula is a somewhat puzzling one for some to handle, iter has deduced the following modifications for cases in the stroke of the engine is 1½ times the diameter of the r, L being the length of the stroke in inches.

n $L = 2\,l$, $r = .06D\sqrt{m}$. (26a)
$L = 2.5\,l$, $r = .068\,D\sqrt{m}$ (26b)
$L = 3\,l$, $r = .074D\sqrt{m}$. (26c)

rther simplification of these formulas for the various maxi- ressure in use may be made, and they may be brought to m $r = FD$. (26d).

values of F for the different values of and for the three tions of l to L are shown in the following table:

| | When l = 2L. | When l = 2.5L. | When l = 3L. |
|---|---|---|---|
| m = | F = | F = | F = |
| 240 | .236 | .268 | .291 |
| 280 | .245 | .277 | .303 |
| 320 | .253 | .288 | .313 |
| 360 | .261 | .296 | .322 |
| 400 | .268 | .304 | .331 |

e proportions of length and the maximum pressure to be ed vary from those given in the above table, the next value should be taken. The proportions derived will be lose to the correct result.

pears to be the most common practice in gas engine con- on to use a connecting rod of the marine type, as shown 20. The proportions for the various parts of the rod e brasses are based upon both the diameter of the rod and meter of the pins. In Fig. 23. the mean diameter of the rod is marked r, the diameter of the crankpin q and the diameter of the piston p. These proportions are:

$a = 1.2\,r$. (27)
$b = .285\,r$ (28)
$c = .5\,q$ or at least $.8r$ (29)
$d = .6\,P$ or at least $.5r$. (30)
$j = k = .85\,P$ (31)
$r = s = .85\,q$ (32)
$m = .17\,P$ (33)
$n = .17\,q$. (34)

Dotted lines at f and g show short projections from the ends of the rod into the brasses for the purpose of holding them in line. Quite often the projections are on the brass and the hole is bored in the end of the rod, but the method illustrated is much simpler to make, as the projection on the rod may be turned in the lathe and it is much easier to bore the hole in the brass than in the rod, as any one who has run a lathe will probably see. The proportions given above are intended merely as a guide to the designer, and are derived from tables of dimensions of gas engine connecting rods which are in daily use. The taper of the rod or the difference between the diameters at A and at B is about ⅛ inch to each foot of length between centers.

The application of formula (26d) may be shown by means of the following example: Suppose it is necessary to find the mean diameter of a connecting rod for a 20 x 50 engine, when the length of the rod is 70" center to center, and the maximum pressure is 300 pounds. The length of the stroke being 1½ times the diameter of the cylinder, the formula 26 d will apply. The pressure is not given in the table, nor is the ratio of the length of the rod to the stroke, which is 70 ÷ 30 = 2 1/3. If it is desired to get very close to its correct value it may be done by interpolation as follows: First, find two values for F corresponding closely to 300 pounds in the columns $l = 2L$ and $l = 2.5L$. As 300 is half way between 280 and 300, take half the difference between the values opposite these figures and add them to the values opposite 280. Half $.253 - .245$ is equal to .004 and $.245 + .004 = 249$; $.288 - .277 = .011$ and half of .011 is .0055, say .006; $.277 + .006 = .283$. These are the figures that correspond very nearly to the values of F when the pressure is 300 pounds and when $l = 2L$ and $l = 2.5L$ respectively. The ratio 2 1/3 is 3/5 of the way between 2L and 2.5L, and to get the right value of F for this ratio, take 3/5 of the difference between .249 and .253 and add it to .249. This difference is .034 and 3/5 of .034 is nearly .021. Hence the value for F is $.249 + .021 = .27$. The formula then becomes $r = .27D$ and since $D = 20"$, $r = .27 \times 20 = 5.4"$, say 5⅜ or 5½ inches.

* * *

## WONDERFUL AXLE.

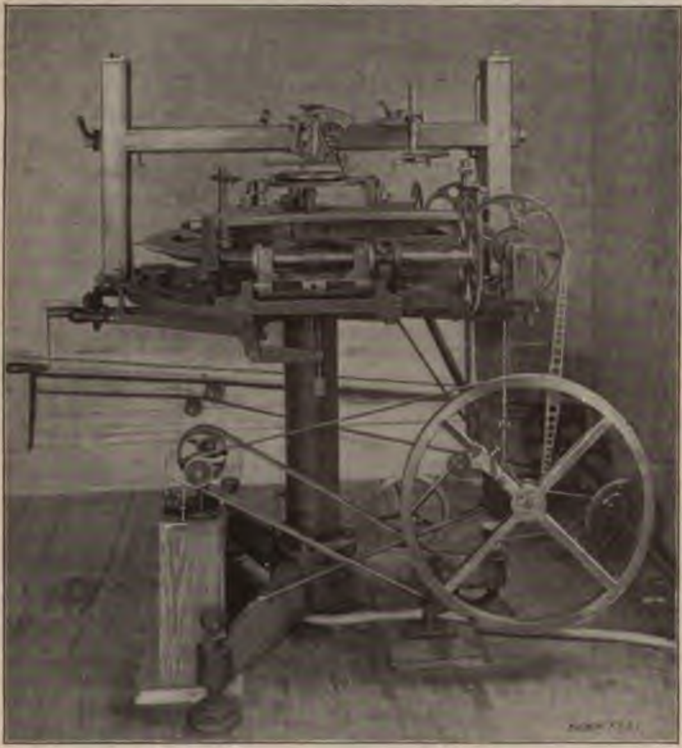
(Special Cable to the N. Y. Herald.)

Paris, Thursday.—A big locomotive is nearly ready for the Northern Railway. It is twenty metres (sixty-five and a half feet) long, and has five axles, of which two are forward, two driving and a big axle at the rear, which, it is claimed, gives great speed.

Attached to it is a tender having four wheels and carrying 6,000 kilos (six and three-fifth tons) of coal and twenty cubic metres (706 cubic feet or 4,402 gallons) of water.

## AN AUTOMATIC DIVIDING ENGINE.

The advance made in astronomy, and in civil engineering during the last two centuries, has been made possible by the perfection of the telescope, the fine and accurate graduation of the circle, and the skill applied in the combination of metals in the construction of instruments of precision. The demands of the users of instruments have taxed the ingenuity of the makers, constantly requiring greater perfection, and the greatest difficulty has been to divide the circle accurately into degrees, minutes and seconds. It is only within recent years that machinery has been constructed that will do this graduation work with almost absolute accuracy, and at the same time automatically. To-day there are less than a dozen first-class dividing engines in America.



A Machine that will Divide within Two Seconds of an Arc.

In a recent number of the "Engineering News" was an article by C. L. Berger, Boston, Mass., containing a description and illustration of a dividing engine designed and constructed by William Wurdemann, Washington, D. C., and now in possession of Messrs. C. L. Berger & Sons, Boston, Mass. From this article the accompanying notes are taken and we are indebted to the "Engineering News" for the photograph from which the illustration is made. This dividing engine is worthy of note, not only because of its novelty, but because of the accuracy attained in its use. It is claimed for it that it will divide a circle within an error of two seconds of an arc, or, expressed in clearer terms, this error, if laid out on the arc of a circle four miles in diameter, would amount to but one inch.

On the main iron circle of the engine is inlaid a silver ring graduated to 10 minutes of arc, a space corresponding to one of the teeth on the edge of the circle. This graduation can be controlled by four micrometer-microscopes for verification of the work of the engine. The circle is moved by a tangent screw gearing, one revolution of which moves the main circle 10 minutes of arc. A drum head on the tangent screw is graduated into 120 spaces, which permits the movement of the circle in arcs of 5 seconds. The driving screws are employed, geared together so as to move in the same direction and at the same speed, and arranged on opposite sides of the circle. Driving the circle by two screws tends to divide and equalize any errors or differences arising from slight imperfections in the gear teeth or screws. In consequence of the greater contact surface between the moving screws and the engaging teeth of the screw there is less pressure and friction on the part of the circle engaged by the screws, and the bearing is relieved of side pressure.

With this engine, circles can be graduated in spaces of degrees, and 30, 20, 15, 10, 5 or 2'. Circles are either read by micrometer-microscopes to single seconds of arcs, or to 5, 10, 15, 20 or 30", according to the fineness of the graduations, by the use of verniers; or by a special vernier to hundredths of a degree, instead of minutes. On top of the graduating circle is placed the centering apparatus, whereon the circle to be graduated can be mounted and truly centered and clamped, so that each circle will truly coincide with the vertical axis of the dividing engine. This is accomplished by a spirit level reading to single seconds of arc. To graduate a circle to half-degrees requires about three hours; if a finer graduation is required a correspondingly longer time is necessary. The whole engine is so arranged that it works automatically. It is driven by an electric motor and requires no personal attention when once started.

The axis of the circle is of novel shape; it is a perfect cylinder where it is attached to the circle, and ends below in a hard steel cone which bears the weight. The effect of this long cylindrical axis is that the circle turns with uniform ease under all conditions of temperature. The axis enters a cast-iron column, into which its upper end is perfectly fitted, so as to turn easily without any possible shake. The column is supported on a cast-iron tripod with leveling screws that step into iron cups. The engine is made of iron and steel and the most important parts are hardened. The circle and its bearings are of hard cast-iron, a dense metal, with a small coefficient of expansion by heat which reduces to a minimum the variations due to changes in temperature.

* * *

In a recent paper, read before the Engineers' Club of Philadelphia, John Birkinbine presented many interesting facts relating to the utilization of waste products, one of which has special interest for tin-plate manufacturers. Mr. Birkinbine says: "The possibilities of utilizing waste in a single direction were suggested by a visit to a large button works in Connecticut, where I was informed that 90 tons of buttons had been made in one month. The material used to produce these buttons was the remnants of the sheets of tin plate from which the bottoms and caps of cans for blacking and other boxes had been cut. After the button blanks had been punched from this tin-plate the small triangles of metal connected by iron threads were compressed in a form under a drop-hammer, and subsequently shipped away to be made into sash weights."

* * *

## ABOUT ARMAMENT AND ARMOR PLATES.

During the exercises celebrating the seventy-fifth anniversary of the Franklin Institute of Philadelphia was an address by Rear Admiral Melville upon the modern warship. In the course of his address, which has recently been published in the "Journal" of the Franklin Institute, reference was made to the guns and armor of our modern ships. He stated that a 12.5-inch breech loading rifle 50 calibers long, and weighing 83 tons, will propel a shell weighing 880 pounds, by a powder charge of 624 pounds, at a velocity of over 2,620 feet per second, giving an energy at the muzzle of over 40,000 foot-tons, capable of penetrating at the muzzle over 45 inches of iron. This energy means that one of our battleships of about 12,000 tons displacement, and which could carry four of these guns, would at a single discharge develop a power sufficient to lift her bodily nearly 15 feet. It can readily be imagined, therefore, what the effect of a projectile from one of these guns would be when striking another vessel at close range.

It is an extremely interesting story to read of what has been appropriately styled the "duel between guns and armor." As fast as one is improved so that its victory over the other seems assured, some inventor comes to the front with an improvement in the latter, which for a time puts it ahead. The armor on our monitors during the Civil War consisted simply of a number of one-inch plates bolted together. At the present day, a modern projectile would go through such armor as easily as a bullet penetrates pine boards, but long ago it was discovered that a given thickness of armor was much more efficient if rolled in a solid plate, and this was developed until some of the older English battleships had iron armor as thick as 24 inches. The development of the gun soon showed that it was impossible to keep pace with it by mere additions to the thickness of the simple armor, for a point was quickly reached where it was impossible to carry the necessary weight of armor that would be thick enough. Then came the use of special plates, the compound armor, where a hard face to break up the projectile was welded to a softer back to give the necessary strength. This was followed by steel armor, and then by the well-known Harvey process, which resembled the compound armor in having a hard face with a softer back, but where the plates were made from a single ingot without any welding. The Harvey process enabled an enormously greater resistance to be obtained with a given weight of armor, but even it has been surpassed by the Krupp process, which enables 12 inches thickness to give the same resistance as 15 of Harveyized plates.

The tendency just now in naval design seems to be in the direction of having only one class of armored vessels which will be very powerful armored cruisers with good armor protection and high speed. This means a vessel of about 12,000 to 14,000 tons displacement, with 8 to 10 inches of Krupp armor, a battery of 10-inch rapid fire guns and a speed of about 20 to 21 knots.

In connection with this subject it will be interesting, also, to quote from a paper that recently appeared in the Proceedings of the Engineers' Club, Philadelphia, with regard to armor plate. The Krupp gas process, as it is called, is a secret process and the rights of its manufacture must be obtained through the famous Krupps of Essen. Krupp armor shows remarkable toughness combined with all the hardness of the best face-hardened armor; and, unlike armor manufactured by other well-known processes, the Krupp product maintains these qualities in the very thickest armor. The thickness of the hardness of Krupp's process is about 1.7 to 2 inches.

The Harvey process consists of the introduction of carbon by cementation into the face of an ordinary low carbon-steel plate, and subsequently it is water-hardened similar to an ordinary tool. After this treatment it presents a hard-faced surface to the depth of about one inch, designed to stop and break up projectiles before serious penetration takes place.

As armor plates must necessarily be secured to the frame work of a vessel to hold them rigidly in place, a serious difficulty is met with. In order to secure the plates, they must be drilled and tapped, and while this can be done before hardening, it is impossible to do it after hardening by any known means, until the plate has been annealed. Drills of every design and method of tempering have been tried, but with no success; the plates cannot be drilled without annealing. The question of being able to anneal the spots was thus becoming a serious matter; but, as many times before in other work of difficult character, the subtile fluid was the only agent that solved the problem, so also in the case of taking the temper out of certain spots to permit the drilling of holes in the harveyized plates, electricity came to the rescue on the eve of despair and failure. The Thomson Electric-Welding Company of Lynn, Mass., made some experiments on harveyized plates, and very soon demonstrated their ability to anneal any surface however hardened, by sending a current of large volume through any spot to be annealed, and by this means raising the temperature of the spot to about 1000° F.; and at that temperature there can be little doubt that the temper has been withdrawn.

The interesting operation of annealing a plate is performed in the following manner: The transformer is placed in position, the contacts touching the plate on either side of the spot marked for annealing. Then the primary current is brought up by means of the rheostat, near at hand, to from eighty-five to ninety-five amperes for a period of from four to five minutes. The metal between the two contact places soon attains a dull red heat, and this temperature is experimentally found by holding a small pine stick in contact with the spot until it takes fire. This is the maximum temperature desired to anneal the spot properly. The current is now gradually diminished by turning the rheostat handle one point each minute until all the resistance is placed in circuit, and by this method the spot is gradually cooled and the chilling of the plate prevented.

By a simple process it is possible to harden the spots again, except that in this case the current is turned from the contact points suddenly, which causes a hardening instead of an annealing action.

## NUMBERING HAMMER.

ROBERT GRIMSHAW.

In the forest and lumber yards of Germany and Austria there is used a style of hammer for marking logs and boards with consecutive numbers, which might prove advantageous to pattern shops for marking patterns, and in shipping departments of large manufacturing establishments sending out great quantities of small cases.

The first style has a head with two number-wheels, each bearing digits 0 to 9 inclusive. The thousands, tens of thousands and hundreds of thousands not being so often changed, are not on wheels but on separate pieces c, which are changed as often as necessary by removing the thumb-nut d. Pressing on the latch e, which lies along the handle, permits turning the wheels a, b. This device numbers up to 19,999. Common printing ink is used. The numbers are about an inch high, and are deeply and sharply cut at their edges so as not to require great force to make a deep, sharp impression.

A simpler contrivance is shown in Fig. 2, which has four wheels and numbers up to 10,999, and a stationary "1," and will also print a decimal fraction 0.5 at a separate blow.

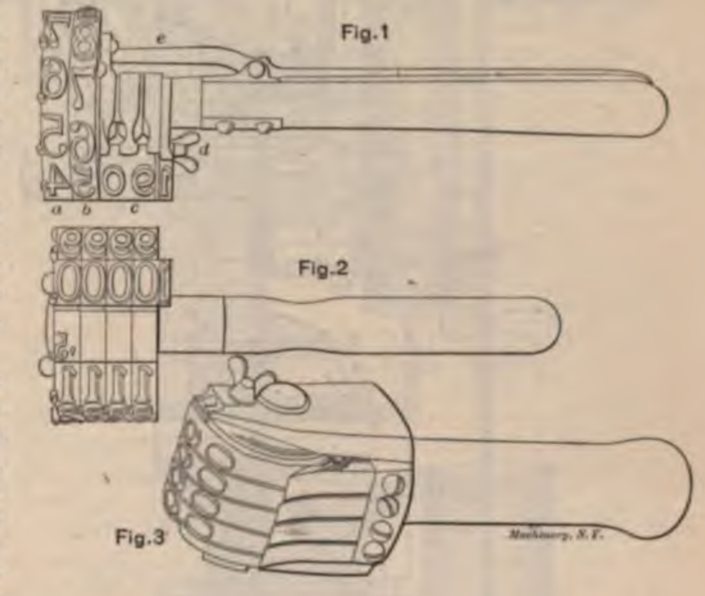


Fig.1

Fig.2
Fig.3

Both these hammers permit of a heavy blow and make a deep impression. Where, however, it is required to make but a light impression, or to make either a light or a very hard blow in a particular place and with greater regard to the direction in which the numbers lie, the four-wheel punch style shown in Fig. 3 is used.

This has a figure for the one hundred thousands, which may be rolled into place and held there when desired; the other numbers are on wheels held by a latch. There is, so far as I know, no patent on the first two styles; on the third only one German "Geschutz Muster" protection.

I suggest that the first may be improved by the addition of a back head, which would not only give greater force to the blow, but permit the use of the tool on very hard woods and in confined places where great exactitude of position is necessary, as it may be placed on the spot where it is desired to number and be struck with a mallet.

* * *

It is difficult to realize that the woman who sent the first telegraphic message—that is, the first practical telegraphic message, as we now understand the term—died only last month. Telegraphy is such an everyday affair to most people nowadays that it seems almost incredible that the person who dispatched the very first message should have just died. Mrs. Smith was not a very old woman—she was 72—but her lifetime spanned a period of marvelous industrial development, and from her father's friendship with Morse she was accorded the unique distinction of sending the first message. The event became historic and made the young girl share in the honors of telegraphy for all time.—Western Electrician.

# LETTERS UPON PRACTICAL SUBJECTS.

## INDEXING ON THE MILLING MACHINE.

*Editor* MACHINERY:

There is scarcely a machinist or apprentice who is not interested in the milling machine, which is an indispensable tool in the machine shop. While many of the readers of MACHINERY are familiar with the subject of indexing, there are probably those among the younger ones, to whom a few words on the principle of indexing may prove interesting. The dividing shaft of the indexing head on a universal milling machine usually makes 40 turns to one of the spindle, so that if we have a gear of 40 teeth to cut, one turn of the crank is necessary for each tooth. For any required number of divisions, the shaft should be turned 40/x turns. Thus for 8 divisions 40/8 = 5 whole turns. Again for 80 divisions 40/80 = ½ turn. If it is required to cut a 25-tooth gear 40/25 = 1 15/25 = 1 3-5 turns. Now, looking over the index plates furnished with the machine, for a circle of holes which can be divided by the denominator of the fraction (in this case 5) either 15, 20, 25, etc., would do. Suppose we find one of 20 holes, then 20/5 = 4 and 4/4 × 3/5 = 12/20; then, one complete turn and 12 holes would be the required division for each tooth. Sometimes an odd division is required which cannot be obtained in the usual way, by the index plates furnished with the machine. In cases of this kind the problem can usually be solved by differential or compound indexing. Thus, for a gear having 69 teeth, if there be no index circle of 69 holes, the division may be obtained by differential indexing; that is, by using the back stop pin in one circle of holes, and the front pin in another. Thus, 40-69 = 63-69 — 23-69 = 21-23 — 1-3, then by moving the crank 21 holes on the 23-hole circle, and then leaving the front or crank pin in its hole, in the index plate, take the back or stop pin out and move the plate and spindle backwards, 5 holes in the 15-hole circle, or 6 holes in the 18-hole circle, or 7 holes in the 21-hole circle, according as to which is used. This will give the required 40-69th of a turn of the dividing shaft. Again, suppose there is a gear of 81 teeth to be cut, and no index circle of 81 holes at hand. This may necessitate going around with the spindle a number of times, say 10. 81-10 = 8 1-10, then for each time around there would be 8 1-10 divisions. We could prove this graphically by drawing any circle of convenient diameter and dividing it into 8 1-10 divisions. Then, by stepping around the circle 10 times, there would be 81 equal divisions. After calculating and looking over the index plates, we may find the nearest approximation to be 5 5-41 turns — 9-49 of a turn; that is, 5 complete turns and 5 holes on the 41-hole circle, and backward 9 holes on the 49-hole circle. That the error in this is slight can be easily shown. Thus, $5\frac{5}{41} - \frac{9}{49} = 4\frac{1885}{2009}$ and $\frac{40}{4\frac{1885}{2009}} = 40 \times \frac{2009}{9921} = 8.09999+$ and $10 \times 8.09999+ = 80.9999+$. It is apparent that this variation is so small as to make no practical difference.

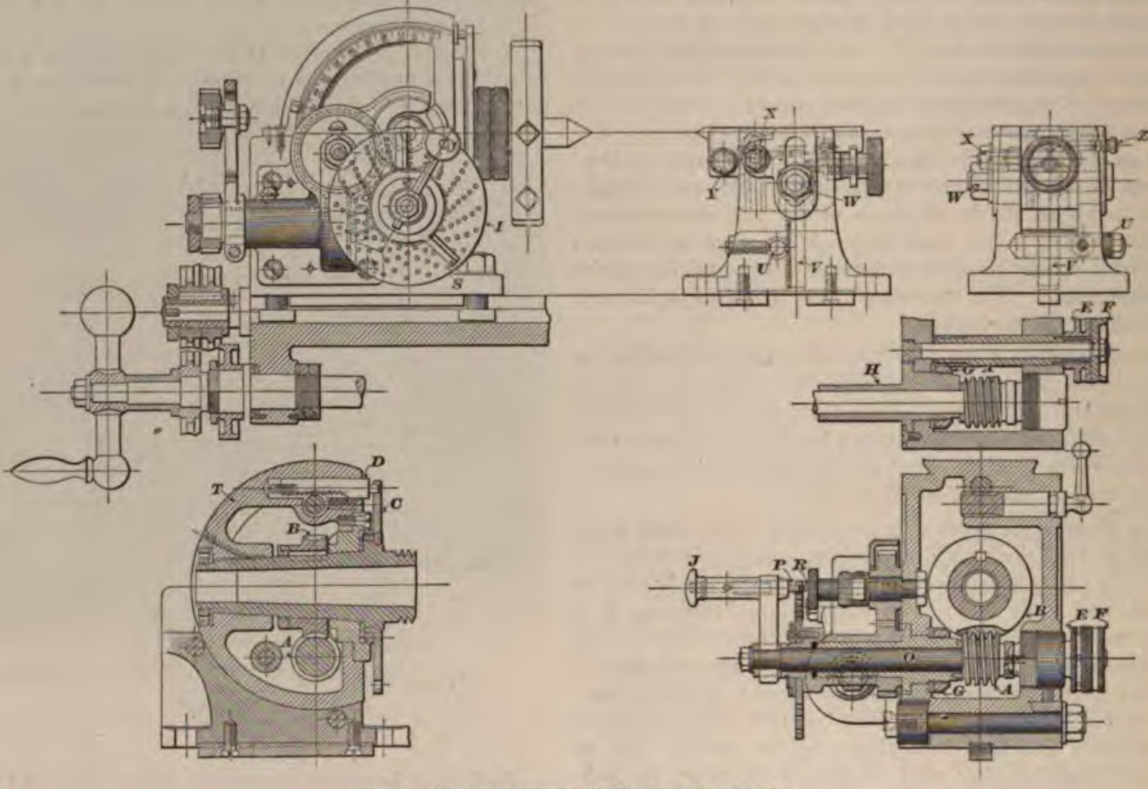


Fig. 1. Details of Brown & Sharpe Index Head.

The accompanying views in Fig. 1 show the construction of the Brown & Sharpe index head, the crank-shaft and worm being indicated by O and A, the stop-pin by P and the back stop-pin by R. Fig. 2 shows how we made the back stop-pin of our machine fit into four circles of holes. A circle of holes that we desired to use came to one side of the back stop-pin; so a segment was riveted on to the face of the pin R and a hole drilled through it of the same size as the holes in the index plate. A removable pin p was used instead of the back stop-pin, which was pushed out of engagement with the index plate. The pin p was removed when moving the index plate and then pushed through the plate into the hole in the riveted piece b.

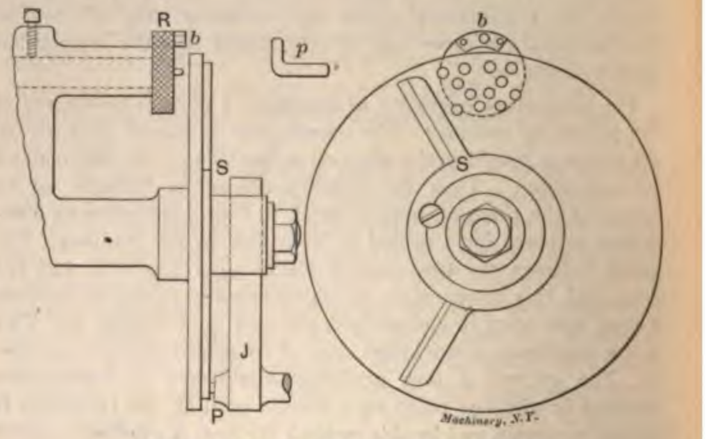


Fig. 2. Attachment for Compound Indexing.

The method of compound indexing is pretty thoroughly explained in Brown & Sharpe's "Treatise on Milling Machines," which gives solutions that require the index plates furnished with their machines mostly. Compound indexing admits of a variety of solutions. It might be interesting if some of the readers of MACHINERY would contribute upon this subject.

JOHN T. GIDDINGS.

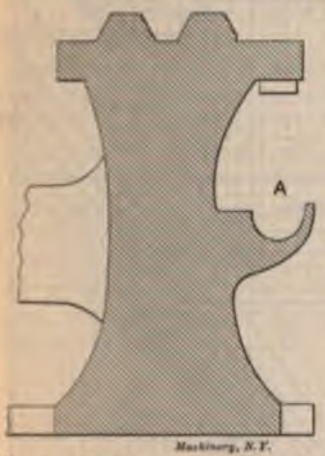
East Providence, R. I.

* * *

## METHOD OF SUPPORTING LEAD SCREW ON OLD LATHE.

*Editor* MACHINERY:

I have read with much interest Mr. F. Emerson's article in the February number, giving his method of supporting long lead screws on a lathe, and possibly a method I have seen in use for accomplishing that end may interest him and others.



Section of Lathe Bed Showing Method for Supporting Lathe Screw.

A long trough A was cast integral with the front of the bed, as shown in the sketch, and the lead screw laid therein. The trough being the same length as the threaded part of the screw and of the same internal diameter, the screw was thoroughly supported. It had the usual bracket bearings at the ends. The nut was like an ordinary split nut without the lower half, the upper half being worked by a lever in the apron in much the usual manner. The lathe is in use every day at the present time.

McKeesport, Pa. E. J. H.

* * *

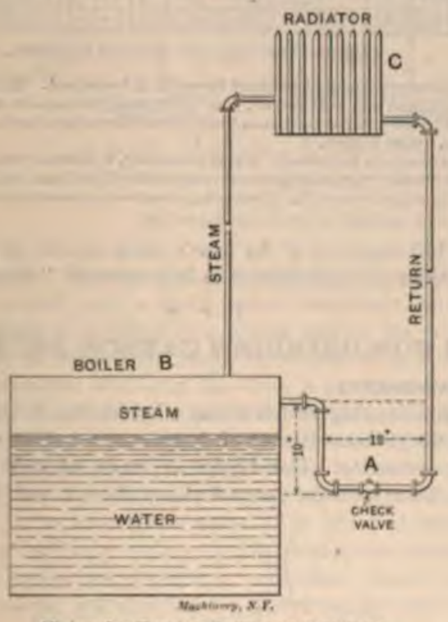
## TO PREVENT RADIATORS FILLING WITH WATER.

*Editor* MACHINERY:

I had the same trouble with my steam-heating plant as mentioned by H. H. in question 33 in the January issue of MACHINERY and show him, in the accompanying diagram, how he may overcome the difficulty. If he will pipe his boiler and radiators as shown so that a trap is formed in the return pipe at A and have the return pipes inclined throughout their length towards the pocket, the circulation will be in the right direction and the radiators will keep free from water.

F. H. NEAL.

Meadville, Pa.



Piping for Heating Boiler and Radiator.

* * *

## A GRAVITY SUPPLY FOR STEAM BOILERS.

*Editor* MACHINERY:

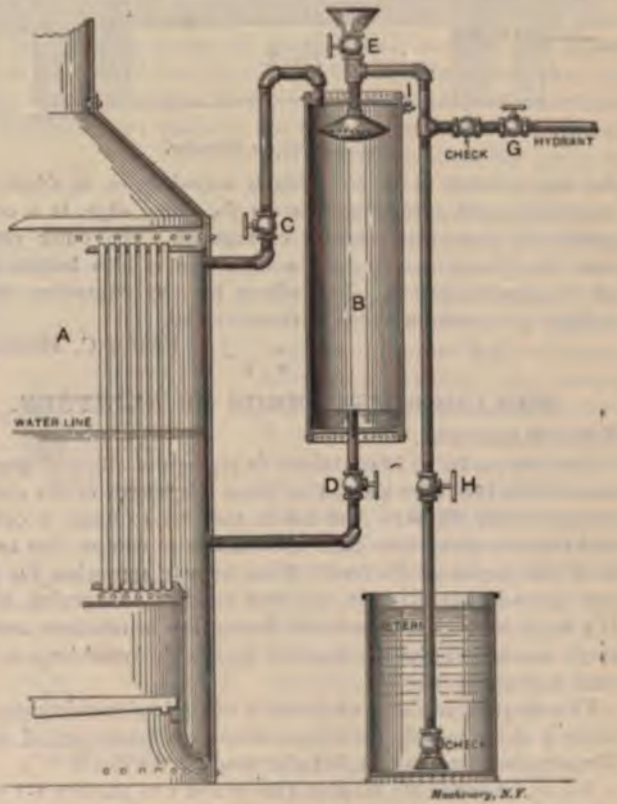
To the readers of MACHINERY I submit a novel method of supply for steam boilers with feed water, while under pressure. The principal feature of this device is its simplicity. It is easily applied and manipulated. It is excellent for laboratory purposes where the absence of the pulsations of a pump or injector is a factor. For experimental work in steam and hot water, or in compounding and mixing under high pressures and temperatures, it will be found a safe and reliable arrangement.

In the annexed sketch, A is the boiler to be supplied with water, while under high pressure; B is a reservoir made sufficiently strong to stand the boiler pressure, the bottom of which is placed at or above the water line in boiler; C is a valve in the steam pipe leading from the boiler to the top of the reservoir; D is a valve in the supply pipe leading from the bottom of reservoir to the boiler below water line; E is a valve with funnel for charging the reservoir; G and H are valves on the supply pipes from the hydrant and cistern; I is an air cock to allow the air to escape from the tank while charging.

To operate this gravity device, first charge the tank, either through the valve E or from the hydrant and, when full, close the valve E. If you wish to use the hydrant, leave the valve G open and if the cistern be used, open the valve H and close the valve G. After steam is generated and feed water is required open the valve C on steam pipe, which allows the boiler pressure to enter the reservoir, thus equalizing the pressure and closing the checks on the hydrant, or cistern pipes, as the case may be, then open the valve D, in the supply pipe. The water in the reservoir being under the same pressure as that in the boiler, and above its line, will flow by gravity into the boiler, thus supplying it with the amount that is in the tank. Then close the valves C and D. The steam remaining in the reservoir will condense and form a partial vacuum which will allow the water to flow in from the hydrant pressure or, by atmospheric pressure, from the cistern. The water in flowing into the tank passes through a douche or jet which sprays the water and condenses whatever of vapor remains in the reservoir. This operation can be continued as long as there is steam in the boiler. I have demonstrated the practical utility of this device on more than one occasion, and it needs only a trial to be properly appreciated.

GEO. C. STANLEY.

Norfolk Navy Yard.



Gravity System for Feeding Boilers.

* * *

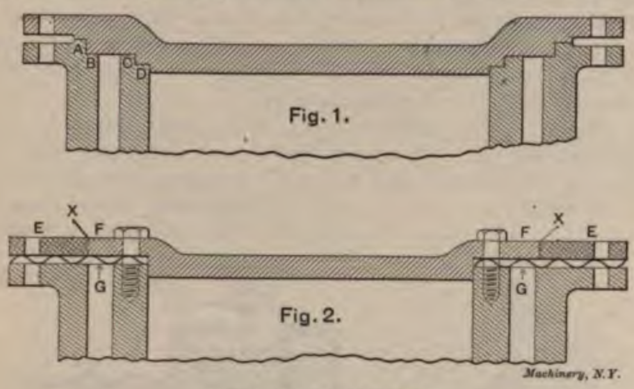
## DRAFTSMAN VS. SHOPMAN.

*Editor* MACHINERY:

Without the slightest intention of stirring up any discussion or ill-feeling between the shop and drafting room, I show the design of a draftsman who, though a splendid fellow and very bright, had never had shop experience nor much outside work. As will be seen, it is the head of a jacketed cylinder.

The original drawing called for the joints A B C and D in

Fig. 1 and, while these are easy to put on paper they are a trifle more difficult to make in the shop; and, even if made, the unequal expansion raises Cain with them when they are in service. The shopman kicked right away, on account of the expense it would be to make these joints and his experience told him they would not stay tight; so a perfectly flat head was substituted. This, however, wasn't a howling success and finally Mr. Shopman suggested the head shown in lower cut, Fig. 2. The cylinder is faced off perfectly flat and the main head F is also perfectly flat and extends to X X. This is bolted down as shown, but under this, and extending clear to the outer edge, is a copper gasket G, preferably slightly corrugated. The outer ring E slips over or around the main head and is also bolted down on the copper gasket. This allows for any expansion, makes a tight joint and has been very successful.



Double Head for Cylinder.

**Frank C. Hudson.**

* * *

## THE CIRCUMFERENCE OF ELLIPSES.

*Editor* Machinery:

Has any reader of Machinery, in laying out elliptical gears or some other job, ever wanted to know the length of the circumference of the ellipse? And did he then try to figure it out and find that the authorities differ so much as to compel him to step it off with a pair of dividers? If so, he may appreciate the short way given by the diagram, one that requires no figuring, either. It's easy; just try it once by following the instructions and example worked out on the diagram itself with dotted lines to help steer a clear course.

This diagram is also a whole table of circle circumferences, because a circle is only an ellipse whose diameters are all equal. The top slant line, ratio 1, is to be used for the circle.

While the scales are marked 1 to 10 and 1 to 32, they are really good for any figures; the 1 may be read as 10, 100, 1000, or fractional as 0.1, 0.01, etc. Of course, whatever ciphers are added must be added to all the other figures in the scales.

This diagram has been worked out by a rule given in the "Home Study Magazine," which says that

$$C = \frac{3.1416}{2}(D + d)\left\{1 + \tfrac{1}{4}\left(\frac{D - d}{D + d}\right)^2\right\}$$

$C$ = circumference.
$D$ = major diameter.
$d$ = minor diameter.

This looks rather formidable, and is rather long; but let it once be figured out and plotted on a diagram and it is only a peculiar curved line.

Take the second example given with $D = 8$ and $d = 2.5$, then the rule works out $C = 17.5$, which is fairly well approximated by the 17.55 from the diagram.

Some other authorities give other rules.

Nystrom says

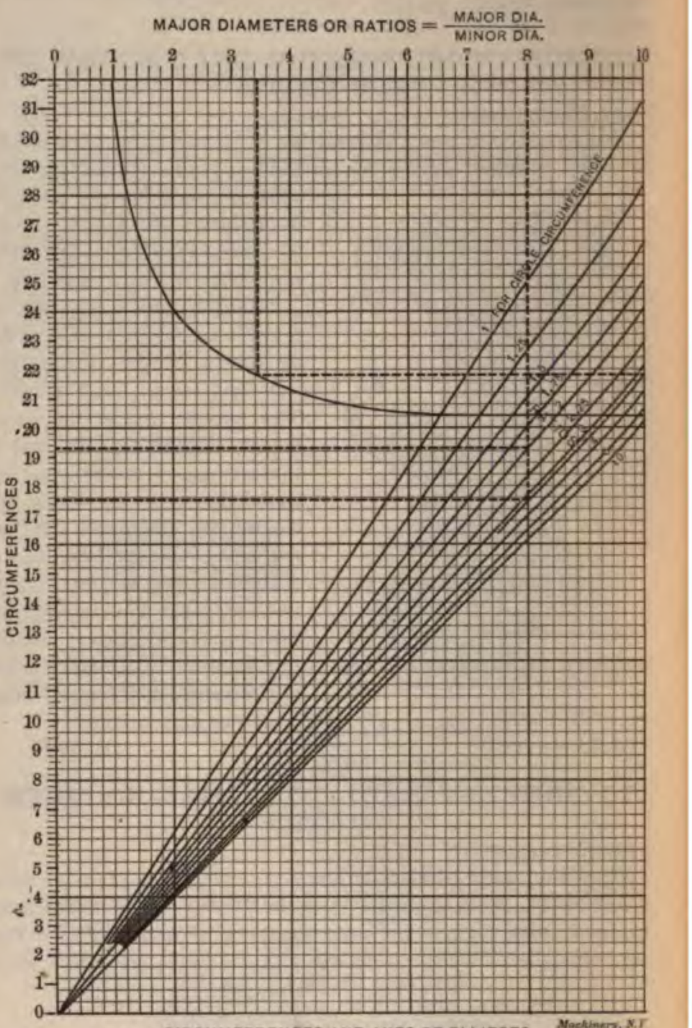
$$C = 2\sqrt{D^2 + 1.4674\,d^2}$$

and while this is shorter, it is also short in the result, as it gives only 17.1 in the special case used.

Molesworth makes a stab with a great big bowie that looks like this

$$C = \frac{\pi}{2}\left\{\sqrt{\frac{D^2 + d^2}{2}} + \frac{D + d}{2}\right\} + 0.1039\,(D - d).$$

and comes out 18.001. That is what he calls an approximation. Now while Nystrom might make a man feel that he probably could keep his waist belt tightened up a notch, Molesworth certainly does not believe that "enough is as good as a feast," but wants to kill by indigestion; at any rate he would be exceedingly likely to kill one's job if the boss's eagle eye lit on the botched resultant from an implicit trust in Molesworth.



CIRCUMFERENCES AND AXES OF ELLIPSES.

To find circumference when slant for ratio is inscribed. Given major diameter, 8 inches, and minor diameter, 4 inches; then ratio equals 2. Trace major diameter 8 inches down to slant 2, then across to vertical scale and read circumference, 19.35 inches.

When no slant is inscribed. Major diameter, 8 inches; minor, 2.5; ratio, 8-2.5 or 3.2. Trace 3.2 down to curve, across to right hand edge; from intersection lay in slant toward O. Proceeding as above gives circumference, 17.55 inches.

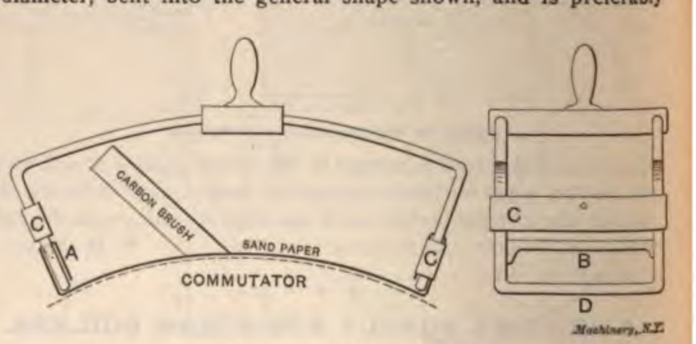
**Henry Hess.**

* * *

## RIG FOR GRINDING CARBON BRUSHES.

*Editor* Machinery:

The accompanying sketch shows a holder that I made for sandpapering the carbon brushes of dynamos or motors to fit the arc of the commutator. The holder is made of stiff wire ¼" in diameter, bent into the general shape shown, and is preferably fitted with a handle, for convenience in using. It has the piece B fitted between the frame at each end and soldered fast. A sleeve from falling off the ends of the wire frame. To use the device, a strip of sandpaper is bent around the end of the frame as shown



Holder for Grinding Carbon Brushes.

nd the sleeve C pushed down to hold it in position. The per is then passed under the brush so that the abrasive presented to it and then bent around the other end of the and secured by the holder as in the first instance. Now, sping the handle (or the frame, if a handle is not provided) he sandpaper pressed down to the commutator, the brush quickly and easily ground to the correct shape, by worke rig back and forth.

Wm. W. Cowles.

rington, Conn.

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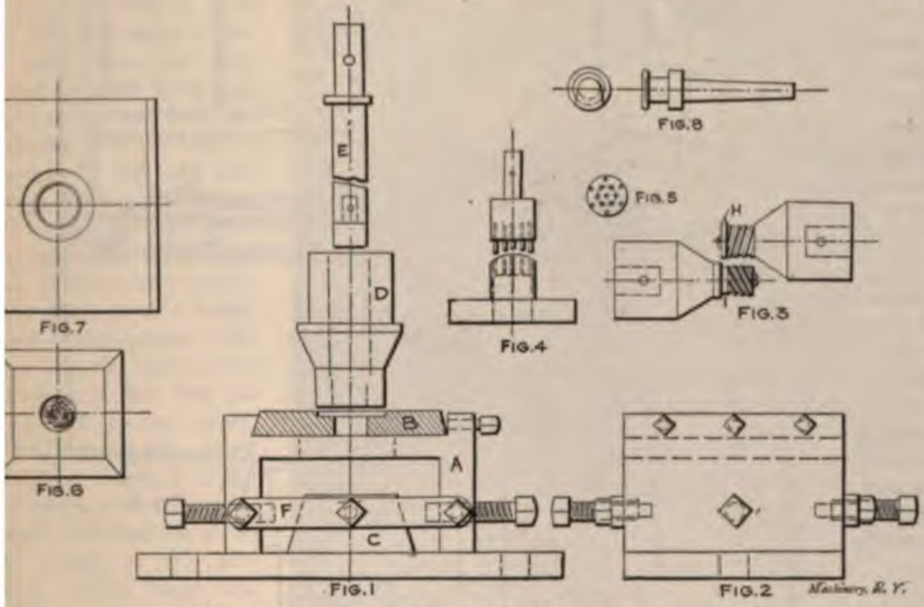
## SALT AND PEPPER SHAKER CAPS.

Machinery:

w many persons in using a salt or pepper shaker stop to how the caps are manufactured, the stock used in nearly es being sterling silver. As I have never come across an on this particular subject, I will endeavor to give the s of Machinery a description of the art of making these nd also of the tools used in their manufacture. I was em- in a shop near New York whose business was composed y of the manufacturing of novelties of silver and gold plate, ost prominent article being salt and pepper caps which sold to outside parties, placed by them on the bottles and n the market.



Jigs and Tools Used in Making Salt and Pepper Tops.

begin with the first operation, the silver is melted in a cru- and poured into a mold, more commonly called an in- fter which it is rolled in a rolling mill to the thickness de- which in most cases varies from .005 to .010 of an inch. g the process of rolling, the silver is annealed several times awing slowly through a gas furnace. After it has been put gh the rolls for the last time, it is again annealed and then d. The annealing of silver causes it to become discolored e process of pickling removes all substances adhering to it eturns it to its original color. The silver is then stripped proper width by rolling through a machine termed shears. next operation practically comprises three operations: g. drawing and striking the figure on the top of the cap. ools used for this work are shown in Fig. 1, in their rel- positions as they go into the press. The press is called a e-acting press, owing to the fact that it has an outside or g plunger and an inside or drawing plunger, the outside er cutting the stock and the inside one (which works through ter plunger) drawing the stock into the form of a cup. A, , is the holder which is bolted to the bed of the press. The r contains the cutting and drawing die B and the engraved which strikes the figure on the top. D is the cutting plun- hich fits the large part of the hole in die B which cuts out ank for drawing. E is the drawing plunger which fits the part of the hole in die B, allowing space for the stock to through. The holder is made of cast iron, set-screwed to the dies as shown in Fig. 1, an end view being shown in . Fig. 1 represents a strip of iron bolted to each side of the holder, one end having a slotted hole from which die C can easily be removed by slackening the screws and raising one end. When in use the strap is clamped by the screw at each end, while the screw in the center clamps the striking die to the bottom of the holder. Fig. 7 shows the cutting and drawing die and Fig. 6 the engraved or striking die.

Now comes the operation of spinning, which is done by placing a hardwood block on the spindle of a speed lathe and turning a recess in the end the form of the cap that is to be spun. As there are a number of sizes, styles and figures, there is a separate block for every one. Having turned a recess in the block, a piece of sheet brass, with the same form and figure stamped into it as those on the caps to be spun is placed in the recess and the corners are turned and tacked on the sides of the block. This is called a jacket, and a jacket with the block is termed a chuck. A tool to hold the caps in the chuck is shown in Fig 8. This tool is used as an ordinary lathe center, one end being fitted in the center hole of the footstock, the opposite end being turned to the shape like that of the cap to be spun. There being one or more beads on nearly all of the caps, the center has to be formed the same shape. If it were round, the caps could not be removed after the spinning had been completed. To overcome this obstacle, the back of the center is turned off just enough to allow the cap to be pressed forward and slide over the top of the beads and drop off.

The next operation is to thread the caps as, in nearly all cases, they screw on at the bottom. This threading is done on a machine built for that work and which contains two spindles, one directly above the other and geared to travel in the same direction, the upper spindle being in a movable arm which is raised and lowered by a cam from the back of the machine. This arm has an adjusting screw to allow for the adjustment of the top tool to the various sizes of caps. These tools are shown in Fig. 3. The bottom tool or the one on the stationary spindle has a right-hand thread cut on it, the top one a left-hand thread. A recess, I, Fig. 3, is turned in the bottom to allow the cutter H on the top tool to cut the caps the desired length. When in position or when the threads properly mesh, the tools are held in position by a check nut. The tools once set, the machine is started. A cap is placed on the lower tool arm; by pressing a foot treadle which releases a clutch, the shaft with the cam on it revolves around once, which action raises the movable spindle until it comes in contact with the cap. These spindles revolve six times the revolutions of the cam shaft by which means the cap is rolled four times before it is released. It is then taken off the tool and replaced by another without stopping the machine.

The next operation is that of piercing the holes in the top of the cap, which is accomplished by using the tool shown in Fig. 4. This is simply a cutter and plunger, the cutter being made of one piece of square steel and the upper end turned the exact size and form of the cap in connection with which it is to be used. It is then counterbored from the bottom as shown by the dotted lines and the small holes for the piercing are then drilled and slightly tapered from the back to allow the piercings to fall out. The cutter is then hardened, which brings our attention to the plunger which is made as follows: A piece of steel is turned with a shank that fits a foot-press this being the machine used for that work. The body of the plunger is turned large enough to allow the counterboring of a hole in the end the size of the cutter. It is now ready for the piercers which are made of Stubbs steel wire cut the desired lengths. The wire being the right length, no turning or fitting is necessary. One piece is placed into each hole in the cutter, each piece being forced into the cutter a given length. As the top of the cutter is irregular in shape, it allows all the piercers to do this work at the same time. Having the wire in place, the opposite ends are filled the same length on the bottom of the hole counterbored in the plunger. The plunger is then placed in a holder, with the counterbored end standing upright; the cutter, with the piercers remaining in their respective positions, is placed on the plunger, the piercers extending into the hole. Lead is now poured into the hole till it is filled and this, cooling gradually, holds the piercers firmly in place. When the piercing is completed, the caps are taken to the polishing room and the inside is scratch-brushed with a wire wheel. Then the caps are polished and washed and are now ready for shipment to be placed upon the bottles that adorn our tables.

A. F. Notroh.

* * *

## BLUE PRINTING APPARATUS.

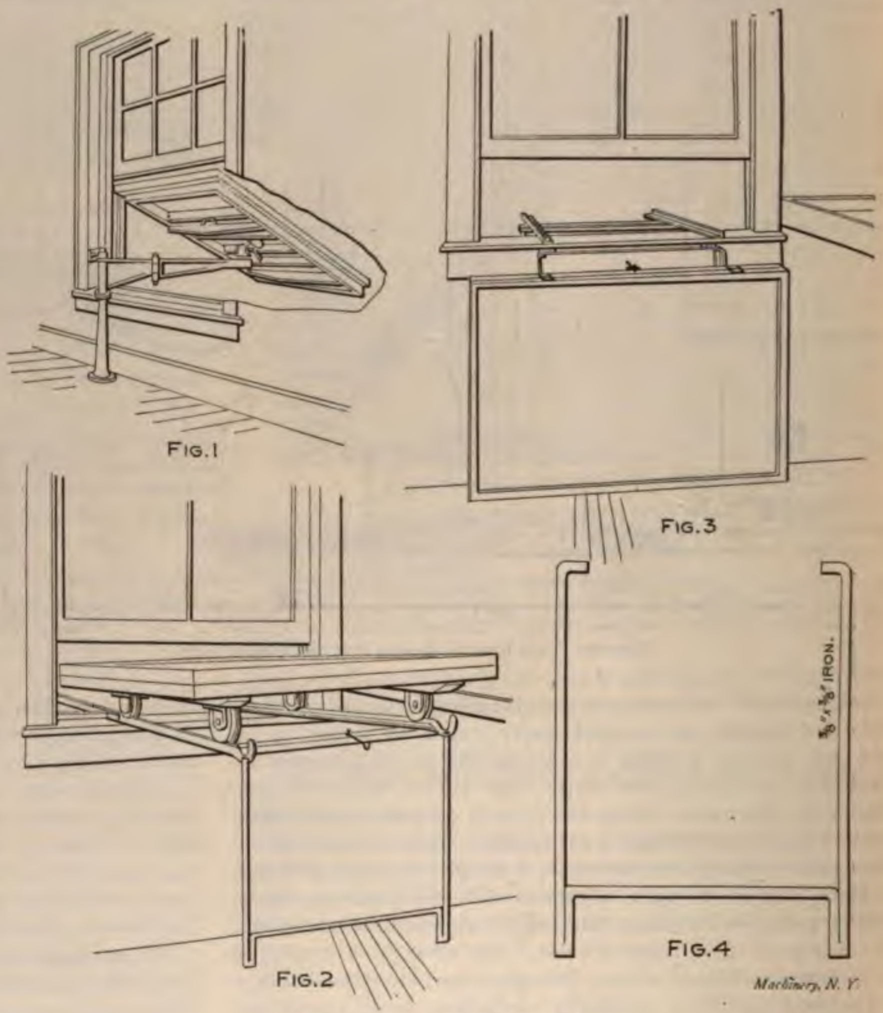
*Editor* Machinery:

After moving into new quarters at the works where the writer was once employed, it was found necessary to design and build a frame or apparatus for exposing blue print paper and the tracing to the sunlight.

The idea of a frame holding the glass and laid on a padded platform on wheels and allowed to roll on a track through an open window was the first and simplest thought of, but floor space was too valuable to permit of such an arrangement. Then, since some sort of folding frame had to be used, the one shown in Fig. 1 was studied on, but the conclusion was reached that it would be more expensive and heavier than necessary. The matter gradually reverted to the first idea, but with the addition of some means to fold it so as to occupy as little space as possible. The results of our thoughts on the subject prove a very neat arrangement.

The two views, Figs. 2 and 3, show a rolling frame made to be hooked to the portion of the track inside the room, and the track is hinged to the window casing so that by removing a support, the whole can be lowered against the wall. It was found that by allowing 1" around the glass for frame, a 24" x 30" glass could be used. The frame and platform were built to suit these dimensions, cotton and cloth being used to form the pad. The frame was hinged to the rear edge of the platform and the weight of the glass was sufficient to hold the paper and tracing secure. The track was made of 1" angle iron, the ends curved up with a "drop" to keep the carriage or platform from rolling while changing prints, and the section of track outside the room was set at a slight incline, with the outer ends turned up to avoid accidents. The track inside the room had holes in the "drop" ends for the reception of the legs, which were shaped like Fig. 4. There was enough spring in the legs to permit them being put in and taken out.

By hooking the track to the bottom of the padded platform and removing the legs, the whole could be let down against the side of the wall under the window casing, the hinges on the glass frame preventing it from sliding off. Notches were cut in the window sash to fit over the track that ran outside and that section was supported rigidly to the outside of the house.



Illustrating Blue Printing Frame.

By the side of the frame in the room was a zinc lined tank, made to be raised and lowered the same as the frame, and when in use it occupied the same space from the wall as the frame, and about the same when dropped down. The tank had a plate on the bottom threaded for a ¾" gas pipe which was used for the leg, and a pipe was used to empty the water, both being removed when ready to let down. A movable frame with cords and clips or clothespins was suspended over the tank, so that the prints when washed could be hung up and the water drip back in the tank. When not in use the legs and pipe were placed in a corner, back of the case for drawings, and the frame with the pins was let down against the wall by a supporting string.

Taken as a whole, it was a very compact and simple apparatus and was of greatest convenience, since it could be put in place in a moment. The writer gives the idea to any who may be so situated as to need such an arrangement.

Birmingham, Ala. W. D. Browning.

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## A TEXAS METHOD OF FIXING PISTON VALVES.

*Editor* Machinery:

I had a little experience recently that may entertain and instruct some of the younger machinists, especially those who were raised in country towns and who served their time in country shops as has been my "doom" in life.

About two years ago I had to fit a solid piston valve and guarantee it to be tight and satisfactory to the sawmill man for whom it was done. I had no reamers to ream out the valve chamber, so I bored it out the best I could and then turned the valve to fit. I spent about two days grinding, filing and polishing with emery cloth before I could get it into working shape. After all my pains I thought that it was a fine fit, but it was not, although the sawmill man paid for the job just the same. I had no automatic grinding machine or lapping apparatus as you eastern mechanics have, but had to depend entirely on "elbow grease."

A few days ago I had a similar valve to fit, which was 3½" in diameter for an Armington & Sims engine, and decided to try a different method. I bored out the valve chamber as smoothly as possible and turned the new valve to a light driving fit. After getting everything ready, a few pieces of oil-soaked waste were collected and put in and around the valve chamber and fired. After the chamber was quite well warmed up, I thrust the valve into the chamber with a coating of fine crushed steel and oil. It was turned and worked back and forth quickly to prevent sticking and after a few moments removed and wiped off. After repeating the operation, I found, to my surprise, that good were being obtained and very quickly. The job, when eted, made me feel so proud that I thought that possibly MACHINERY readers might be interested in the "kink."

Antonio, Texas. H. WEIERHAUSER.

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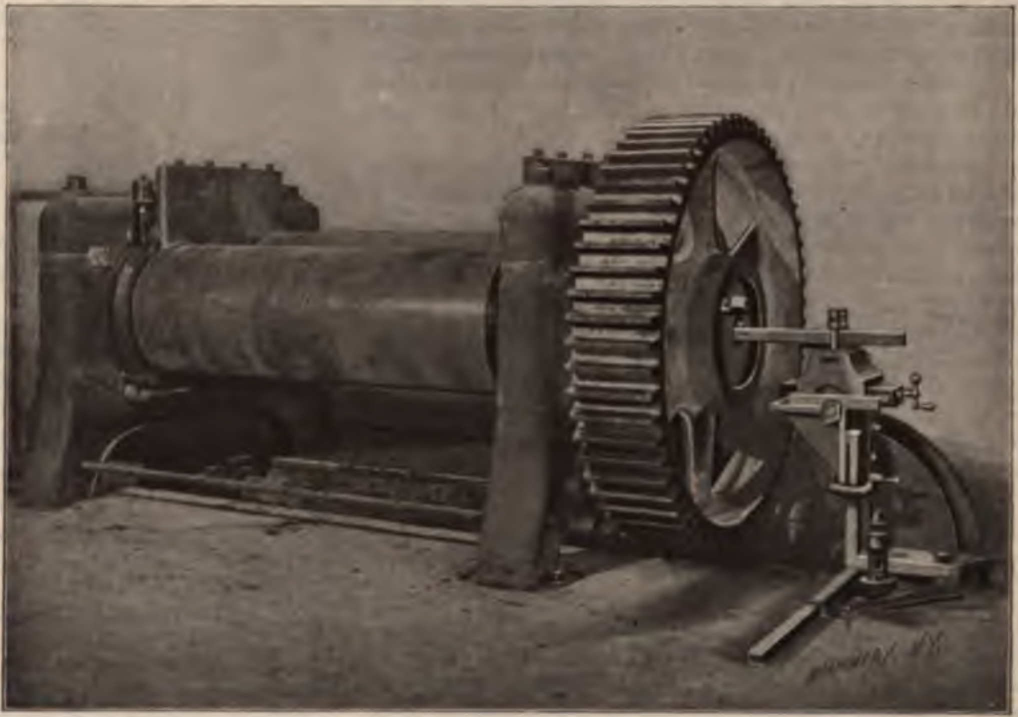
## ORING A ROLL UNDER DIFFICULTIES.

MACHINERY:

ve been a constant reader of MACHINERY for over three and have received through its columns many inspirations ich I have been better able to overcome many obstacles ave confronted me in the duties as foreman of a machine n that time. Believing it is better to give than to receive, after the blessing attached to giving, and will tell your s how we got out of a very awkward predicament in which nd ourselves a short time ago in our factory, hoping it may of value to some of them.

some mishap a 72″ x 26″ chilled roll (weighing about 6,- ounds), ordered to replace another, was shipped to us t being chambered out on the ends to receive the stuffing d gland for the steam and cold water pipes which are used ating or cooling the roll when necessary. Well, I called and by the way that same John is the best man I ever saw ching up a breakdown or g out of a scrape like the e were in), and we went to the mill to look the d over. Then we went o the shop and hunted up gle irons, one with 18″ nd one with 12″ faces, a und slide rest and tool om a 48″ lathe, two heavy of machinery steel with straps and C clamps. ars of steel were placed the shaft pit and bolted foundation plates. The gle iron was then placed them with one face to- the roll to be bored. he C clamps, the second iron was fastened to the ith one face in a horizon- ition, and then the slide- as placed on this and fast. This made our ary boring machine, is shown in the accom- g illustration. A piece -inch square steel was cut to a convenient and a ¾-inch hole was through it near one end for the cutters to be used. crew hole was also drilled from the top to hold the in position. Three double end cutters were used, made inch round, self-hardened steel, to lengths that would up the stock to be removed (which was about 1 inch on a d 4 inches deep), into equal cuts. The metal of the roll hard that turpentine had to be used and with the last cut- had to take advantage of the noon hour and run the at about half speed.



Photograph of Rolls Showing Arrangement of Boring Tool.

e was no lathe in our shop large enougn to handle this d if we had been compelled to ship it back to the maker ored, it would have cost the company not less than $50, , what is of more consequence, about three weeks' time. about eleven hours to complete the job, so we estimated saved our salary for that day at least.

RUB. BERNECK.

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## E NOTES FROM PHILADELPHIA—USING HARTNESS TOOL-HOLDERS IN ENGINE LATHES, ETC.

MACHINERY:

ntly, while in Philadelphia, I spent a very profitable -day in the shops of Bement, Miles & Co. looking at the new tools in process of construction.

Having been quite familiar with the machine tools made by this firm, I was prepared to find careful and painstaking methods followed in their manufacture, and in this expectation I was not in the least disappointed. The scraping of the flat working surfaces of machine tools, which appears so fine in the product of too many tool builders but which is often of not much practical value beyond that it removes the tool marks, is here followed as a means of not only making the flat surfaces smooth and well finished but also uniformly flat and true. The making of accurate flat surfaces for the heavy housings of planers, lathe shears, cross-rails, etc., is a problem not easy of solution. Heavy straight-edges or surface-plates are used for testing when "spotting" down the inequalities left by the planer tool, but when a straight-edge 12 or 14 feet long and 15 inches square in cross-section is used for the work, the difficulties are somewhat increased, as such a mass of metal has necessarily to be handled by a crane and its own weight is enough to slightly deflect it from truth when only supported by its ends. To add to the difficulties of using such large surface-plates, the slight differences in temperature that may easily exist between two opposite sides, make them totally unreliable unless care and judgment are exercised in their use. However, by the use of these straight-edges in conjunction with accurate spirit levels, flat working surfaces are probably made as nearly accurate in this shop as in any other in the country, but to attain the result, time and the services of skilled workmen are absolutely necessary.

Among the notable tools building, I noticed some of the parts of a huge crank lathe for the Westinghouse Machine Co. of Pittsburg. I was informed that this lathe is the third one of the class and size that has been built in these shops, the other two being for the Carnegie Steel Co., of Pittsburg, and the Midvale Steel Co., of Nicetown. The swing of this lathe is 125″ and its total weight is not far from 100 tons. The spindle has 21 speeds and is of cast iron running in cast iron boxes. The steady-rest was being drilled for the bolts holding the jaws while I was there, and it was standing erect. Its height was not far from 8′ and was estimated to weigh not far from seven tons although I think the estimate was too high. At any rate it would be quite a respectable piece of work for the average shop to turn out.

A planer is running in this shop which has been in service nearly forty years and is still doing good work although quite noisy on the return travel. It has been widened out so as to have a capacity of 10′ in width but when compared to the planers of an equal capacity, built at a recent date, it of course appears very light and weak. This planer was run night and day, during the Rebellion, on contract work for the U. S. Government and it is said that on it was earned the foundation of the Bement fortune as prices were received for its services that would now seem enormous.

The foreman of the bolt department has worked out a simple and effective way of making his old engine lathes do as much work in turning bolts as is possible on the Jones & Lamson lathes, of which there are six in his department. The scheme consists simply of using a Hartness tool-holder on the carriage of the engine lathe and locking it so as to be central with the axis of the lathe. The cross-slide of a lathe to be changed over, is removed and the top of it planed off to allow the tool-holder to set at the correct height. It is then bolted fast to the slide and the cross-feed screw removed, the slide being fastened in position by the gib screws. With these old lathes, a boy is able to easily turn 100 6" x 1½" bolts in ten hours and face the under side of the heads. Of course no other operation, such as threading or chamfering the heads, is attempted.

The threading of the bolts used in the construction of the machine tools here built, is required to be as nearly concentric with the bolt as if threaded on centers in an engine lathe. To get this accuracy there has evidently been some trouble, and as the foreman has insisted on there being no eccentricity in the threading, a guide has been attached to the face of the Hartness die which starts the thread exactly square with the axis of the bolt. I have never seen this device used before but am inclined to think that it is a good thing where extreme accuracy is required. The guide does not interfere with threading close to a shoulder as it can be opened after the thread is well started and allowed to hang down out of the way.

Undoubtedly, some machinists and manufacturers are under the impression that the quick change devices now applied to a number of engine lathes for accomplishing the change of lead for any screw by the simple shifting of a lever, is a rather new idea. In the bolt department I saw an old lathe, built over twenty-five years ago, which has this feature, but which is not arranged as neatly and compactly as the gear boxes seen on the modern lathes; neither does it have as great a range, the total number of threads that can be cut by shifting the lever being six or eight. The idea, however, is exactly the same as that worked out in the modern lathes and which is, I am informed, the subject of a suit for infringement. R. P. PERRY.

Hoboken, N. J.

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## CHUCK FOR THIN WORK.

*Editor* MACHINERY:

The chuck described in the March issue of MACHINERY, for boring gears, brings to my mind a chuck which I made some time ago for squaring up some cast-steel discs. These discs were punchings 4" in diameter and 1-8" thick and, as such thin pieces cannot be held securely in an ordinary chuck or on an arbor, they were machined in a special chuck made for the job as follows:

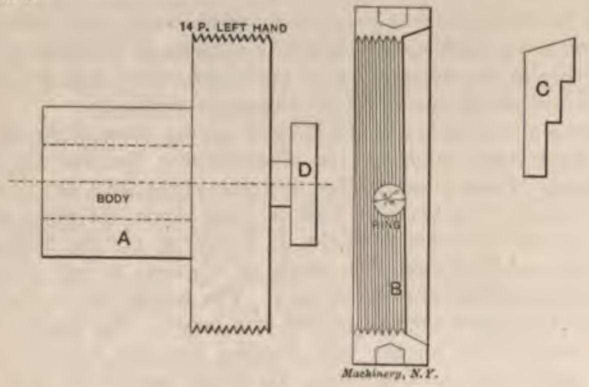

Fig. 1.

The chuck was made entirely of cast iron—body, jaws and all. As the cast iron jaws are easily made, the cost is but little to have a number of sets for different sizes of work. Another advantage of the cast iron jaws is that they are easily trued up. The body of the chuck was made from a casting shaped like A in Fig. 1, which was internally threaded to fit the nose of the lathe spindle. The hub or boss D was turned and a left-hand thread of 14 P. was cut on the large diameter. The pitch of the thread must be left-hand as the jaws have a tendency to turn the ring in a right-hand direction when under the pressure of the tool, and if the ring were threaded right-handed, it would tend to unscrew and loosen the jaws. The ring B was tapered on the inside for a short distance from one side for the jaws C, C, C, etc. These jaws were made from a cast iron disc or plate about 3-4" thick and were tapered on the outer edge to fit the bevel of the ring B. The steps were then cut in the face of the disc to fit the size of piece to be held and then it was still further faced off to fit the recess behind the hub, or boss D, rather snugly. The shoulder outside of this hub was sufficiently relieved to prevent the jaws from tightening on the hub when the work was being chucked. After all this work was finished, the disc was cut into six pieces.

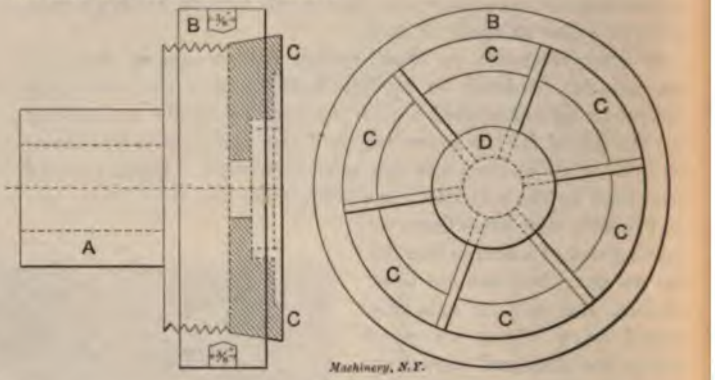

Fig. 2.

The chuck is assembled, as shown in Fig 2, by putting the jaws in place behind the hub and then screwing on the ring B which holds them from falling out and which also forces them against the piece to be held. Four holes are drilled in the periphery of the ring to allow the use of a 3-8" pin as a chuck wrench.

The punchings mentioned were turned up in this chuck and firmly held. The chuck was also used to hold them for grinding after being hardened. One advantage of this chuck over the step chuck, which should be mentioned, is that work can be faced clear to the edge, which is often impossible with the latter. W. A. STINSON.

Dorchester, Mass.

* * *

## A STRANGELY FRACTURED CHISEL.

*Editor* MACHINERY:

I send you herewith two photographs showing a break or split in a handled chisel, that is something of a curiosity. The chisel was made from Crescent steel and has been in use at the boiler shop of Wickes Bros., in this city, about two years. The fracture, as shown in Fig. 2, extends from the head down to the edge and parts the chisel in two so nicely that the cutting edge was divided nearly two-thirds the width. For the remainder of the distance, the fracture did not extend above the ground part. The width of the cutting edge is about 1 5-16" and the length from the edge to the head is 5¼". A. M. BARBER.

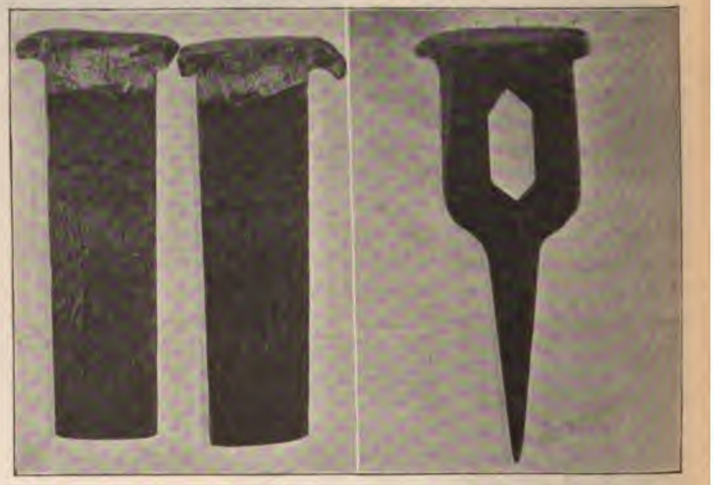

Fig. 1. Fig. 2.

Saginaw, Mich.

[Apropos of this instance, it may be remarked that some lacksmiths temper the heads of their chisels, especially those or cold cutting. The results, when the tempering is properly one, are said to be quite satisfactory, as there is no battering or plitting ,and thus the head is always kept true and the number f broken handles, consequent to "glancing" blows from the elper's sledge, is lessened. The heads are drawn down to about he same hardness or slightly less than that found best for a ammer face.—Editor.

* * *

## A FEW KINKS FOR THE DRAFTSMAN.

*Editor* MACHINERY:

One might think that the drafting room of to-day, with all ts equipments, improved methods, etc, as well as the modern ools for the draftsman, had reached almost a state of perfection; yet in spite of these, we keep finding new tools and better methods, as well as many new ideas that add something to the general advance. Three or four of these helps have caused ufficient interest on my part to note the same and as I have never seen them published, I venture to give them to the readers of MACHINERY, trusting they may be of some interest.

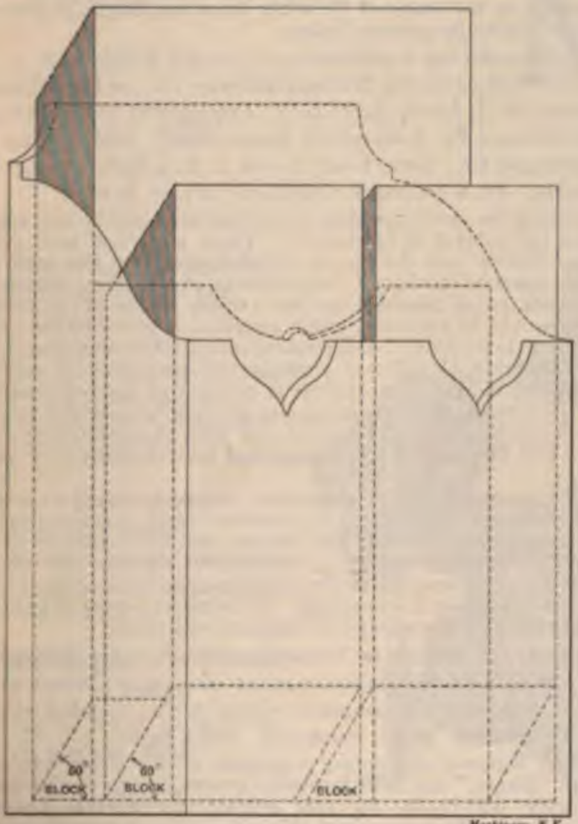

Fig. 1.

I suppose most draftsmen have a little box with three or four ompartments for different sized note paper, and a good many, ike my own, either stand on the table or are fastened to the wall. The compartments are open at the top and are arranged o that the larger sheets are at the back. When one is in a hurry, he will reach for a sheet and most likely get several; two or hree attempts may bring success or he may fail and try again, wetting the tip of his finger. Even this may prove unsuccessful and if so, he is likely to become a little impatient, get on his eet and use both hands or throw the sheets on the table to be eplaced when he has more time, or, most likely, throw them n the waste paper basket. Now, if he will have a strip of wood sawed triangular shape, Fig. 1, having the angular side for the paper to rest upon not less than 45 degrees, preferably 60 degrees, with the base; cut it in pieces just long enough to fit the openings, place the blocks in the paper holder with the high side to the front and then put in the note paper, he will have a holder similar to the one shown in Fig. 1. The top edges of the paper will be on the same angle as the block. I think he will feel well paid for his trouble in the ease with which he can get one sheet when he wants it.

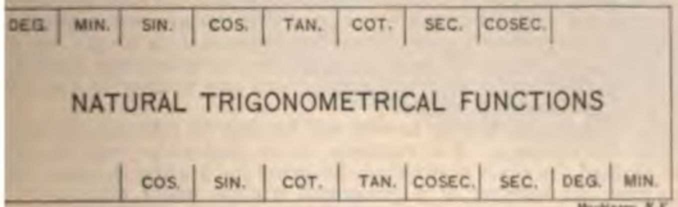

Fig. 2.

Did you ever try to draw with your triangle or straight edge on cardboard or on a surface that was slightly rounding and have them slip out of place? If you will paste three or four pieces of fine sand paper, about the size of a dime, on your triangle or straight edge, you will find that it will stay where you hold it.

In using tables of trigonometric functions, logarithms and others, you will find a help in the following: Take a card the same width as the table and copy on the upper edge the heading at the top and on the lower edge the lower heading. For instance, for the trigonometric table you will have a card like Fig. 2. Move this card down the table until you come to the number or degrees and minutes wanted and you have the heading where you can see it, instead of looking at the top of the table to find your column of sines or tangents and then following down, at the same time keeping your finger on the degrees or number, (whichever you happen to have in finding the other.) With such a card one can find what he wants quickly and with less chance of a mistake.

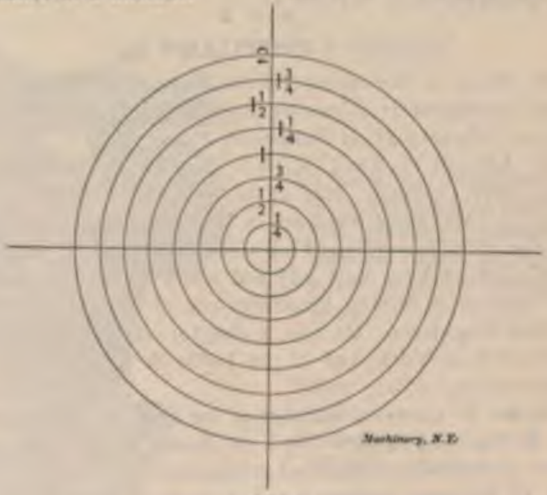

Fig. 3.

Another handy card is one having circles carefully laid out in sizes from 1-16" to 2" in diameter, arranged in groups like the drawing, the smaller ones within the larger, and with the sizes selected so as to have a space between them large enough for the figures that denote the sizes, as shown in Fig. 3. Shellac the card so that it will keep better and stand cleaning. When a certain size circle is wanted, you have only to set your compass to the size desired, and you can usually get a better setting than on a scale, in the same time. On the other side of the card you can draw the different sizes of hexagon heads for bolts, screws, etc., and when you have occasion to draw one, the radii wanted for the rounded top will be laid out ready for you to copy.

Providence, R. I. EDWIN C. THURSTON.

* * *

## ABOUT THE PLANER TOOL HOLDER.

*Editor* MACHINERY:

In the January number of MACHINERY, "A New Planer Tool" is illustrated and described, as manufactured by the Armstrong Tool Co.

I wish to state that the tool described has been in general use in the machine shop of the Pennsylvania Steel Co., at Steelton, since February 7, 1881, and was made by the writer, the only difference being that we did not use the grooves round the edge of the bar to hold the tool from slipping around, as this feature has never been found necessary. On the contrary, the holder is better without the grooves, as in adjusting a broad square nosed tool for finishing, it can be moved around until the exact position is reached and then screwed fast. The object in view at that time was to cut a number of irregular surfaces on the planer smoothly, and the ordinary "goose neck" tool required too much steel and labor to make a number of them. In consequence, a square iron bar was used in the tool holder, with a hole drilled through the lower end, and a small steel cutter of the shape desired was bolted to the back of it. This proved so satisfactory in increased work and economy of tool steel, that the principle of using a small piece of tool steel in a holder (instead of a large solid tool), was adopted at once, and has continued in use since that date, and as before stated, is the same as the one illustrated. Reference to the "American Machinist" of February 26th and April 16th, 1881, will confirm the foregoing statement. GEO. H. ROBERTS.

* * *

### THE THREAD PROBLEM AGAIN.

*Editor* MACHINERY:

Since writing the letter giving the thread problem published in the January issue, I have solved the difficulty myself but have waited to see what the readers of MACHINERY had to say about it. The answer given by Mr. F. T. Miller is a correct solution of the trouble. I found the error by marking on the ways for each advance of the tool for a total of 8 threads and when I had finished, I found an advance of only 7/8 inches instead of one inch which should have been the case. The difference shows a loss of advance which, when compared with the number of threads and the lead, accounts for the difficulty I met. I thank the readers of MACHINERY for the interest manifested in this problem.

Poughkeepsie, N. Y. E. O. JOHNSON.

* * *

### OBITUARY.

Mr. Henry R. Hazlehurst, of the Murray & Hazlehurst Company, manufacturers of marine engines, etc., established in 1850, died on February 21, at Baltimore, Md.

Mr. Addison C. Rand, M. Am. Soc. C. E., president of the Rand Drill Company, died at his home in New York city on March 9. Mr. Rand was born in Westfield, Mass., in 1841. He was one of the founders and for some time treasurer of the Engineers' Club of New York city and was a member of the American Institute of Mining Engineers and of the American Society of Civil Engineers. He was a director of the Ninth National Bank of New York, and of the Laflin & Rand Powder Company.

Charles H. Coster, a member of the firm of J. Pierpont Morgan & Co., died in New York on March 13. He was also director of a number of railroad companies.

H. D. Richards, general foreman of the Bundy Manufacturing Company, died recently at Binghampton, N. Y., aged 37 years.

William C. Ferguson, superintendent for the Westinghouse Air Brake Company, died on March 3, at Pittsburg, Pa.

Gottfried Daimler, founder of the Daimler Motor Company, Cannstatt, Germany, died in that city on the 6th inst., aged 66 years.

William Wallace Rogers, a member of the firm of Woodward & Rogers, machinists and tool-makers, Hartford, Conn., died in that city on March 1. Mr. Rogers came to this country from Paisley, Scotland, and was first employed by the Pratt & Whitney Company.

* * *

### FRESH FROM THE PRESS.

Kinematics of Machinery, by Prof. John H. Barr, M.S., M.M.E., of Sibley College, Cornell University. Published by John Wiley & Sons, New York. 252 pages, illustrated. Price $2.50.

This is called by the author a "brief treatise on constrained motions of machine parts." The book is intended for a short general course in kinematics and gearing for students in engineering colleges. It treats of subjects generally included in such a course, touching upon elements only, yet giving sufficient information to enable one to lay a good foundation for future work. The chapters on cams, linkwork, belts, ropes and chains, and trains of mechanism are presented in about the same manner as similar chapters in other works, but the three introductory chapters of the book, which take in all 78 pages, give a very full and clear course in pure kinematics, developed by Reuleaux methods. These chapters appear to be the distinguishing characteristic of the book.

There is a chapter upon gearing, but this touches only upon the elements. The author states that he does not deem it necessary to give more than a statement of fundamental principles since there are so many books in which the subject of gear teeth is exhaustively treated.

This book, like many of the works produced by those engaged in instructing, is the outcome of several years' experience in the class room and has been gradually developed from notes prepared for students' use. It is, therefore, to be expected that the book will be found well adapted to class-room work and will be free from the defects of books that have not been tried in the class-room. As a logical and concise treatment of pure mechanism, or kinematics—sometimes called the geometry of machinery—we think Prof. Barr's work is one of the best presentations that we have seen.

It may be added that while a course in mechanism, treated as a science of pure motion, is of undoubted utility for an engineering student, no student can become a successful draftsman until he understands the applications of its principles to practical constructive problems. Such a course, therefore, needs to be supplemented by drawing-room practice and by sketches and drawings, or by the examination of actual machine parts, to enable the student to become familiar with the application of its principles. Our only criticism of Prof. Barr's work is one common to most works of this nature and is to the effect that it would be of great help to students if he were to add enough sketches to those given to show clearly some of the applications of the principles to actual practice. While such an addition might be contrary to the scope of the work from a scientific standpoint, it would add to its practical value.

Lubrication and Lubricants, by Leonard Archbutt, F. I. C., F. C. S., Chemist to the Midland Railway Co., and R. Mountford Deeley, M. I. Mech. E., F. G. S., Inspector of Motors and Boilers, Midland Ry. Locomotive Department. Published by Chas. Griffin and Co., Lim., London, and J. B. Lippincott Co., Philadelphia. 450 8 vo. pages, illustrated. Price, $5.50.

This is the most complete work that has come to our attention upon the subject of lubrication. There are a few brief chapters upon friction and the theory of lubrication, but the bulk of the work treats of lubricants, their sources, preparation, examination, and uses, going minutely into the various phases of the subject.

As would be expected, much attention is given to the examination of lubricants, the determination of their composition and the detection of different elements, objectionable or otherwise, contained in them. A chapter is devoted to the systematic testing of lubricants by chemical and physical means and one upon mechanical testing. There are two final chapters upon the design and lubrication of bearings and the lubrication of machinery.

The book is written by two men, one of whom is an engineer, and the other a chemist. It therefore treats of lubrication from the standpoints of both the chemist and the engineer and will prove valuable to either. It is doubtful whether the full value of those parts devoted to chemistry can be realized by one who does not possess a knowledge of chemistry, since many of the tests require a knowledge of chemical reactions.

The Steam Engine in Theory and Practice, by William Ripper, Professor of Engineering in the University College of Sheffield. Published by Longmans Green & Co., London and New York. 400 8vo. pages, illustrated. Price $2.50.

Prof. Ripper's elementary text-book on the steam engine, entitled "Steam," has been favorably known as one of the best elementary text-books on that subject for several years and we have therefore examined this more advanced work with unusual interest. It is in substance the notes that Prof. Ripper has given his classes upon steam and the steam engine and so is primarily intended as a text-book. It is, however, essentially a handbook for ready reference upon the steam engine and as such will be found of great convenience by engineers and designers.

The treatment throughout is brief and a great deal of information is condensed into small compass, as would be the case in a note book. There is a short treatment of the essentials of thermodynamics, and the slide valve, indicator and other standard subjects are given a small amount of space. There are several chapters devoted to subjects that are of the greatest importance, but that generally receive but brief mention in books of this character. One of these is upon the reciprocating parts and their effect upon fly-wheel proportions and another is upon balancing the steam engine.

That the book is up to date will be seen by reference to certain of the chapters. For example, under feed-water heaters is explained the effect of drawing the steam for heating the feed water from the receiver of a compound engine; under governors the inertia governor is discussed; the important question of the effects of the cylinder walls upon condensation in the cylinder and the economy of the engine is given space; and the performance and economy of different types of steam engines, superheated steam, the steam jacket, etc., receive attention. For a concise, yet comprehensive treatise, we can highly recommend the book.

* * *

Worms and worm-wheels are usually cut to a certain circular pitch, as it is more convenient than to attempt the accurate conversion of the troublesome factor, 3.1416.

**BROWN & SHARPE MFG. CO.**

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Auxiliary shaft for driving feed clutch gears.
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Index plates accurately drilled.
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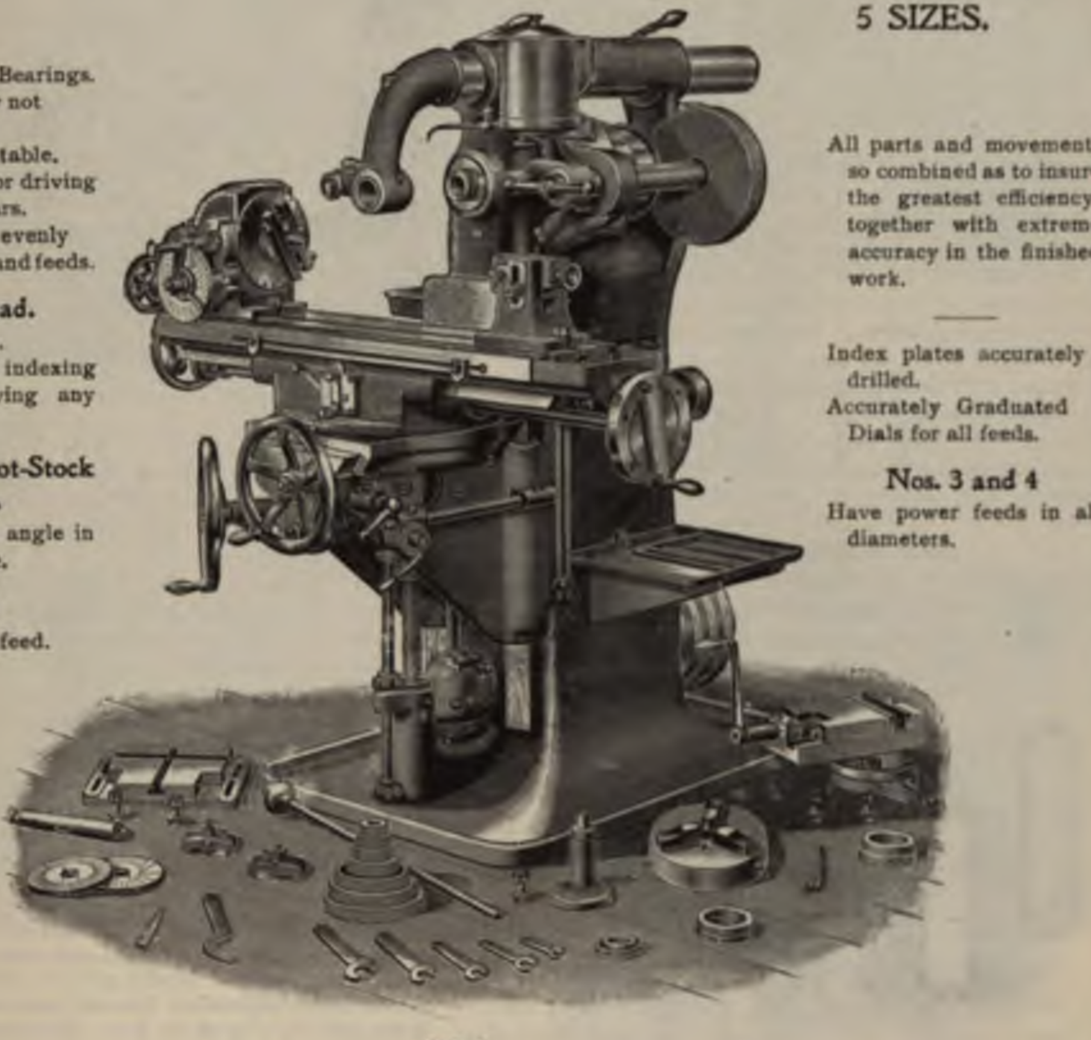

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## NEW TOOLS OF THE MONTH.

**Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.**

### NEW MULTIPLE SPINDLE DRILL.

The six-spindle multiple drill shown in the accompanying halftone engraving represents the smallest of a family of four machines of this type which The Bickford Drill and Tool Company, Cincinnati, Ohio, are just placing on the market.

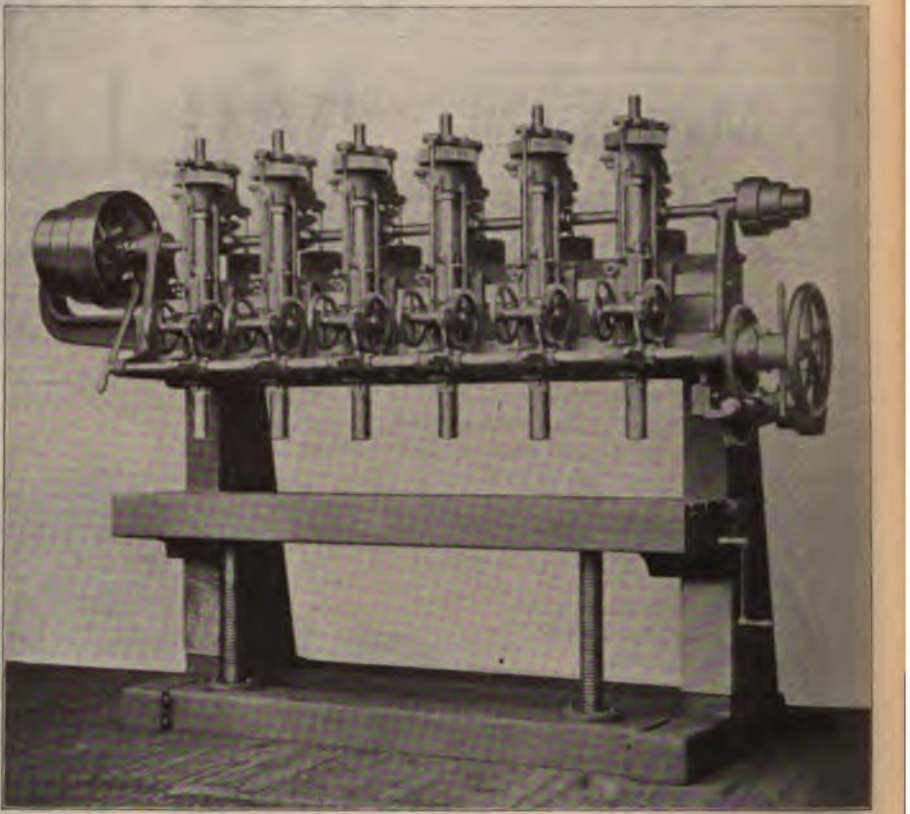
The spindles have six changes of speeds with three changes of feed for each speed, and are provided with both hand and power feed, quick advance and return, and automatic stop.

The heads are composed of the least number of parts consistent with durability and convenience of operation, are adjustable on the rail, and may be used independently or collectively as desired, each head being complete in every particular.

The back gears are located inside of the cone, and are so arranged that they may be instantly engaged, disengaged, or the spindles stopped altogether, by one stroke of a lever. This is a feature that will be found a great convenience.

The rail and table are made in four lengths, ranging from 5 to 11 feet. The 5, 7 and 9-foot tables are adjusted by means of two screws only, while the 11-foot one has three screws, operated in both cases from either end of the machine.

The manufacturers write us that the halftone shows but one of many styles of table with which the machine is fitted, and that the number of heads and form of housings may be modified to suit the requirements of almost any class of work demanding the use of a tool of this character. They also append a number of the principal dimensions as a guide to its general capacity: Diameter of spindles, least section, 1 9-16". Spindles bored to fit Morse Taper No. 4. Vertical traverse of spindles, 12". Vertical adjustment of table, 18". Maximum distance between the table and spindle, 3". Weight, complete, as shown, 6,850 lbs.



Six-spindle Bickford Drill.

### MACHINISTS' SQUARES.

Greble, Turner & Co., Hamilton, Ohio, have placed on the market a set of five try squares for machinists' use, ranging from an 8-inch to a 2-inch square. The object has been to produce a set of squares that should be accurate and satisfactory for all ordinary requirements and at the same time at so reasonable a price that individual mechanics can afford to procure the set or that manufacturers can supply their tool rooms with a number of sets.

Set of Squares, 2 to 8 Inches.

In construction the squares have beams of a fine-grained, hard quality of cast iron and the blades are of crucible steel, not hardened. The beams and blades are both ground all over. The blades are accurately adjusted and held down to their seat in the beam by three nicely fitted taper rivets. In a letter sent us by the manufacturers it is said that it is believed that the squares will wear and retain their squareness for many years, and the fact of their not being hardened makes them less susceptible to changes of temperature or to internal changes than the more expensive hardened squares.

We have had the privilege of examining a set of these squares, and have taken much interest in inspecting them as regards finish and accuracy, because of the low price at which they are sold. They are similar in appearance to the best grade of machinists' squares now on the market. The finish is satisfactory; though less time has evidently been devoted to the final finishing than is given to the best hardened squares, the surfaces are all carefully and evenly ground and look well.

With regard to accuracy, we judge, from a commercial test upon a true surface with the aid of pieces of tissue paper to place between the blades, that they will answer all requirements satisfactorily. The greatest error detected with the blades back to back was less than a thousandth of an inch per foot, divided between the two blades. In testing with one square inside of another, the outer edge of one blade lining with the inner edge of the other, the error in each case was slightly larger, in one instance, as an extreme, reaching, perhaps, 1½ thousandths per foot. The squares are packed in a hardwood case, are warranted by the manufacturers, and seem well adapted to the needs of machinists.

### IN BRIEF.

Speed Lathe, 11-inch swing. R. E. Kidder, 35 and 37 Hermon street, Worcester, Mass., has brought out an 11-inch speed lathe with these features: Head and tail spindles of crucible steel; size of hole in spindle, 9/16 in.; front bearing, 1⅜ x 2¾ in.; composition boxes. Size of cone: small section, 2½ in.; large, 6⅝ in.; 1 9/16 in. face. Tail spindle is easily changed from a wheel to a lever feed and vice versa. There is a shelf on the back of bed for tools. The binders for rest and tailstock are convenient and effective.

Multiple Drill. The Langelier Mfg. Co., Providence, R. I., have placed a four-spindle drill on the market which is intended for manufacturing where pieces are to be made in a quantity.

Shaper. A new shaper called the "Stockbridge" shaper is being built for the Niles Tool Works Company, 136 Liberty street, New York. It has an improved crank motion, a down feed and a number of other features peculiar to this machine.

# MACHINERY.

l. 6. May, 1900. No. 9.

## AMONG THE SHOPS.

### LARGED PLANT OF THE BULLARD MACHINE TOOL CO.—STRIKING EXAMPLES OF JIG WORK.

ing the past year the Bullard Machine Tool Co., Bridge-
Conn., manufacturers of boring mills, turret machines and
have made extensive additions to their plant. Part of
are in continuation of additions to the main machine shop
a few years ago; while a model blacksmith shop and boiler
have been built and a new power plant installed, with a
tor for electric driving and lighting. The total floor space
this year amounts to about 32,000 square feet.

company was established in 1880 as the Bridgeport Ma-
Tool Works, E. P. Bullard, proprietor, and was incorpo-

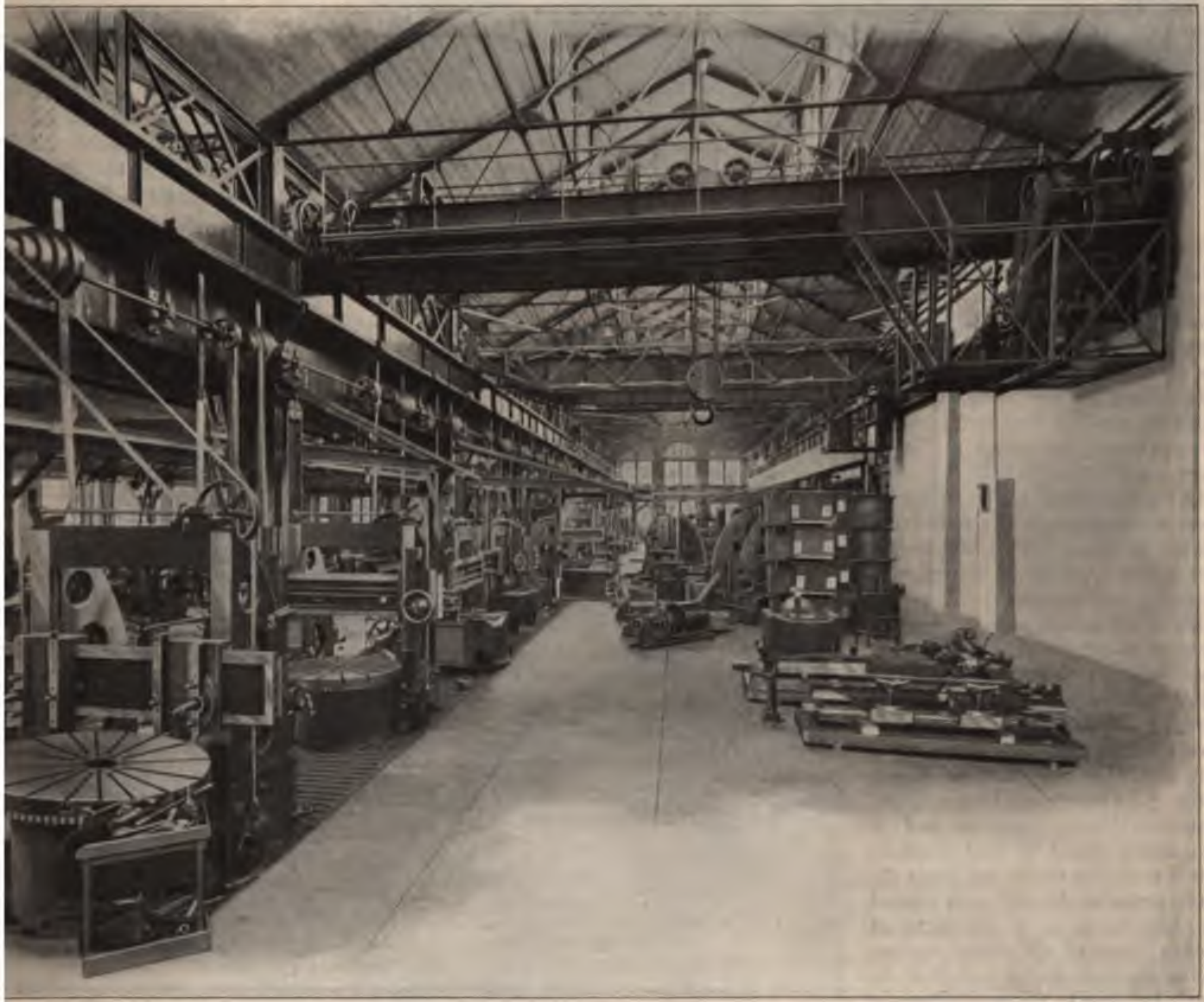


Fig. 1. Central Span of Main Shop. This Section is 40 feet Wide by 275 feet Long, is Served by two 10-ton Cranes and has a Concrete Floor.

in its present name in 1894. It was originally quartered
ur-story, brick building, which forms part of the present
; but aside from this building the structures are of the most
n type of brick and steel construction. An interior view
central span of the main shop appears on this page. This
g is 275 feet long, 40 feet wide in the center, with wings
h side 175 by 40 feet, arranged with galleries of the same
pace, after the usual custom for such buildings. The cen-
an is served by two ten-ton electric cranes.

#### A Few Interesting Features.

ground floor of the main building is of concrete throughout, consisting of 4" of rubble laid directly on the ground and 2" of Portland cement, broken stone and sand for the top. The heavy tools are set on this floor without other foundation and it is found to make a satisfactory setting. The shop is lighted by windows in the roof, of corrugated glass, and by windows at the side. The attention paid to the matter of light is strikingly apparent. The galleries not only have the benefit of the side windows, but of those overhead also; and the shop walls are white inside and outside as well, wherever there are two walls of adjacent buildings coming near to one another tending to shut out the light. It is found that the reflection from these white walls increases the light within the buildings very appreciably.

In the general view of the main floor in Fig. 1, it will be noticed that there is a line shaft just under the girders supporting one of the tracks for the traveling cranes. As this floor is used for erecting boring mills it is necessary to have some convenient method for driving the mills when facing the tables, and also for driving the bars used for boring the vertical bearings for the table spindles. As the mills may have to set at almost any point on the floor, and be started and stopped independently of the others under process of erection, it is desirable to be able to drive them independently, wherever they happen to set. To accomplish this, and also to give a number of different driving speeds, the line shaft referred to is fitted with a number of loose cone pulleys at intervals of a few feet, which are driven through friction clutches. A belt can thus be easily run to a machine in almost any position, any speed within the limits of the cone pulley can be obtained, and any machine can be started or stopped by operating the clutch through which it is driven.

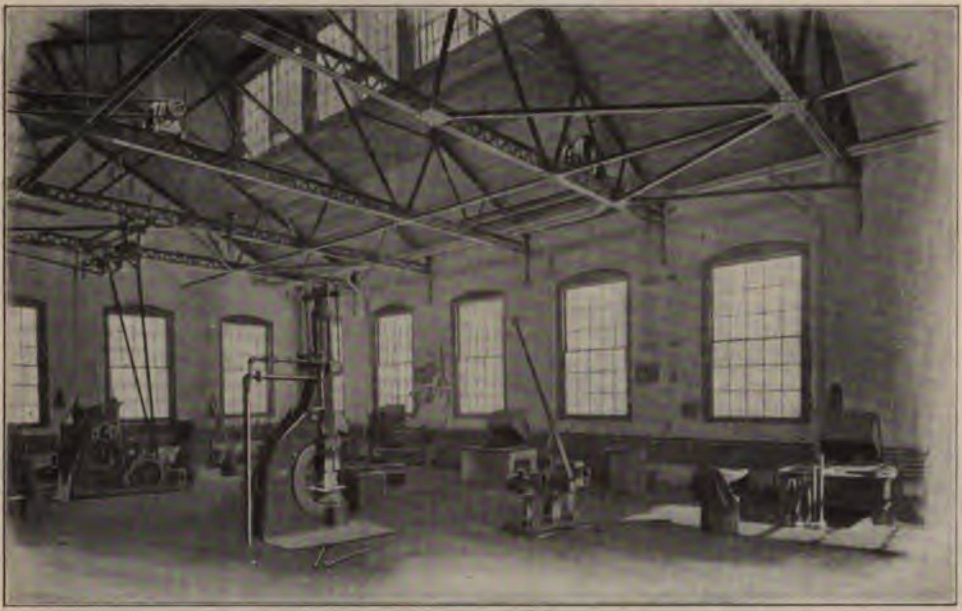


Fig. 2. New Model Blacksmith Shop at the Bullard Co.'s Works.

To further facilitate assembling and erecting, a number of long pits about four feet wide and three feet deep have been dug in the erecting floor and walled up, thus enabling a man to work underneath a machine easily. This is an important matter in building tools of the character of boring mills. To cover the pits when not in use, short lengths of rolled T-beams are employed, the side walls of the pits being capped with castings of a shape suitable to receive the ends of the beams, as indicated in the sketch in Fig. 6, page 259.

In the illustration in Fig. 3 one of these pits is shown with the covering beams in place. This illustration also shows a group of boring mills made by this company.

Many offices have storm doors and possibly an occasional machine shop may be fitted with them; but we doubt whether many concerns have equipped their works with so extensive a storm door as is placed at one end of the main floor of this shop. The building is heated by the Sturtevant hot-air system and is thoroughly warm in cold weather; but it faces the north, and when the large doors at the end were opened to allow trucks to be driven in, so cold a blast of air always accompanied the truck that it cooled off the whole building to the discomfiture of all. An immense vestibule, or air lock, was therefore built inside of this end of the shop to enclose the door, into which a team can be driven when entering. The outside doors are then closed and the inner ones opened and the team can enter the shop without letting in more cold air than is contained in the air lock.

### Shop Fittings.

Several of the shop fittings in use here are shown in the group of sketches on page 259. The shop benches throughout the works have cast-iron supports or legs made from patterns designed by this company, which are of neat design. As shown in Fig. 9, the completed bench has drawers and a shelf underneath for storage. The most novel feature about the construction is the arrangement of the planks for the top. Instead of running lengthwise of the bench, they run crosswise, and so one or more short lengths can be renewed at any particular spot, if worn, without having to replace a large plank. This design is not claimed as original, but embodies features obtained from several sources.

In Fig. 5 is an end view of the scrapers' and fitters' bench that has been found useful, inasmuch as it gives access to the work from underneath. Scattered throughout the shop at the different machines are tool racks which were also built here and do as much as any one thing to preserve an orderly appearance in the shop. They serve as receptacles for tools, castings, finished work, etc. One of these is represented in Fig. 4. The castings for the shelves, a, b and c, are simply hollow, square frames, pinned to the uprights and with wooden shelving. In Figs. 7 and 8 are two styles of racks for storing, in the one case finished work and in the other rough stock. There is nothing particularly new about these racks, but it will be noted that the upper bracket has a wooden strip to prevent marring finished work and that the arms of the rack in Fig. 8 slope upward so that the weight of the heaviest part of the stock will be supported next to the upright.

As before intimated, the shops are lighted by electricity and a large number of lamp brackets made by the O. C. White Co., Worcester, Mass., are in use. These are intended to support single incandescent lamps, the lamp being held by a long, slender arm, which swivels in any direction from its point of support and can be clamped in position. It was originally intended that these brackets be supported from the walls or the ceiling, but a number of them have been attached to cast-iron standards which set on the floor and can be moved about the shop. This convenient arrangement enables the workman to bring the light into just the position best adapted to his requirements.

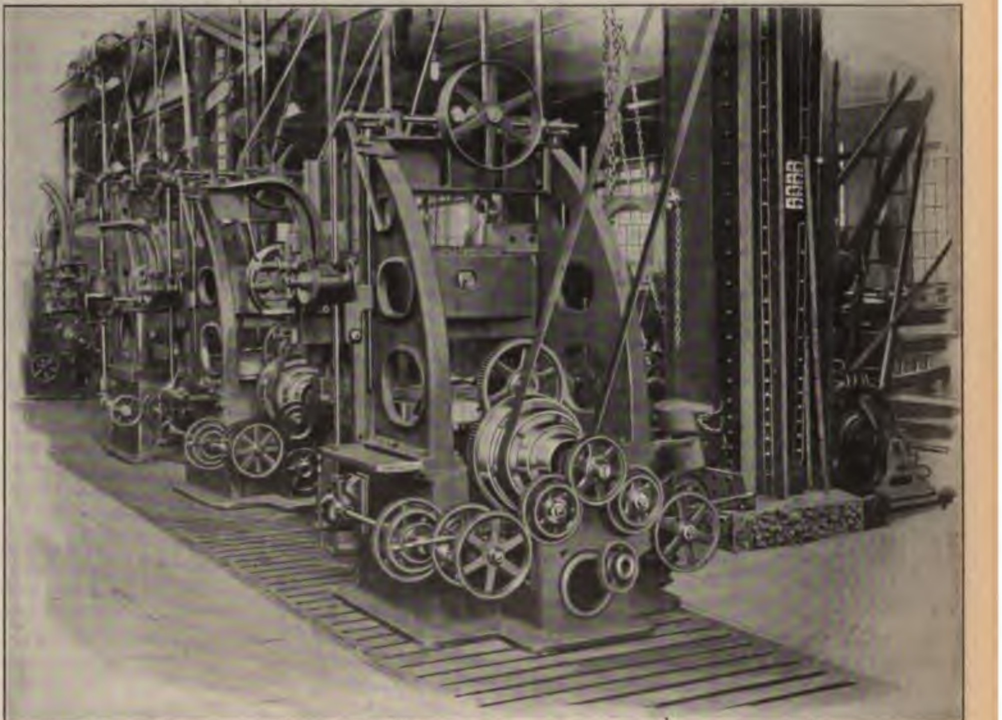
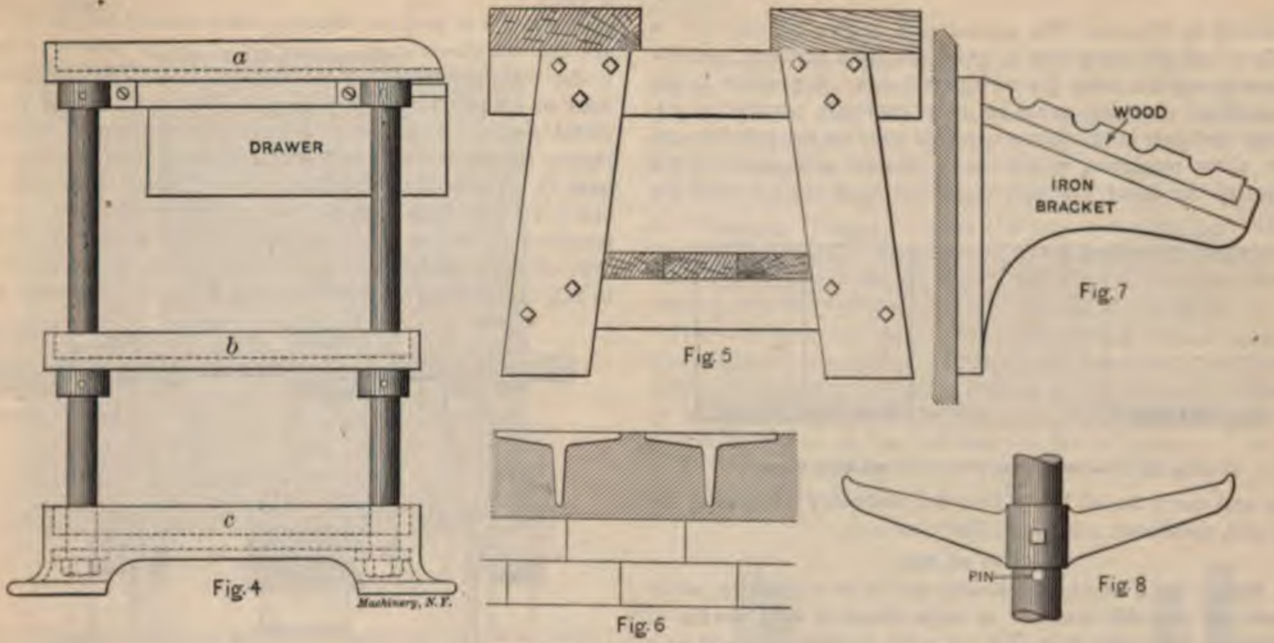


Fig. 3. Group of Boring Mills, Showing also One of the Covered Pits on the Erecting Floor.

### Blacksmith Shop.

In Fig. 2 is an interior view of the new blacksmith shop, which is about as modern and attractive in its appointments as it is



Group of Shop Fixtures.

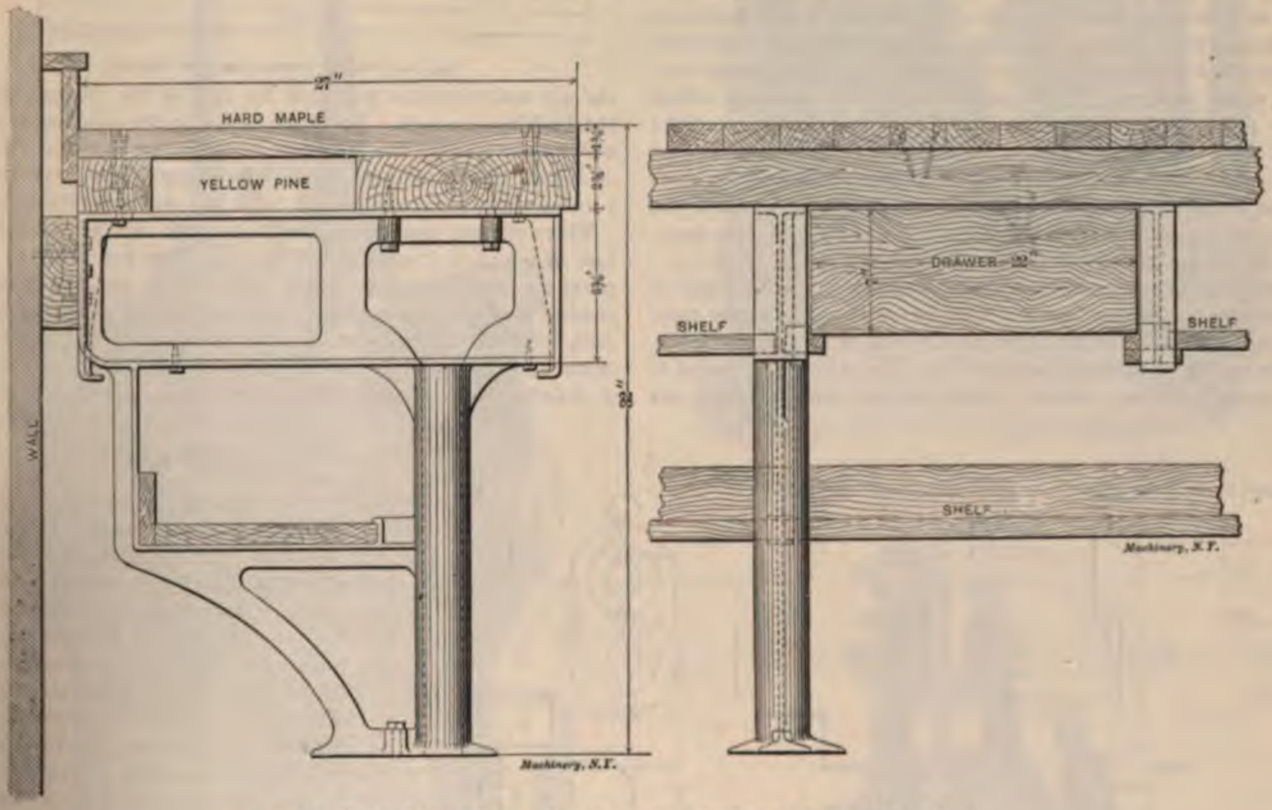


**Fig. 9. End and Front Views of Work Benches Used at the Bullard Co.'s Works.**

possible for a blacksmith shop to be. There are a steam and power hammer and three down-draft forges, besides an ingot forge and the necessary tools. The blast is from an electrically-driven fan and the method of conducting the smoke and gases from the forges is decidedly novel. A chimney had to be built for the new power plant and the idea was suggested and carried out of running a duct from the forges to the space between the outer and inner walls of the chimney, thus allowing the forge gases to escape up the chimney and obtain to a certain extent the advantage of the draft gained from the heat of boiler gases passing up the inner flue, without endangering the boiler draft by connecting the forges directly to the inner flue. The chimney is of brick, 100 feet high, the inner flue is 54 inches in diameter, and the air space of sufficient capacity to carry off the gases from the duct leading from the three forges, which is 24 by 30 inches in cross-section. This arrangement works very satisfactorily, and as far as we know, is new.

Like the other buildings, the blacksmith shop has white walls inside and they were not only painted white at the start, but they are kept white by repeated applications of whitewash. The room is also well ventilated, high studded, has tight lockers for clothing, and sanitary closets.

### General Methods.

It requires but a brief inspection to make it plain that the use of jigs and gages for producing standard work is carried on to an extent in this plant that is seldom seen in machine tool shops. Jigs are not only used for the smaller pieces, but for much of the large work. Their 30-inch boring mills are built throughout by the aid of jigs and, as they are put through in large lots, their production is practically on a manufacturing basis, which experience shows not only makes the very desirable quality of interchangeability a requisite, but actually produces more uniformly accurate work. Through the courtesy of the management we are permitted to illustrate several examples of jig work which we think our readers will find well worthy their attention.

Expanding reamers are used extensively and the means at hand for keeping holes standard is clearly indicated in Fig. 13. This shows a case of standard gages and reamers that are of considerable interest. The gages range from ½ inch to 3 inches in diameter, varying by sixteenths, and are of the design shown in the sketch in Fig. 10. The central part is knurled, one end is standard and the other end is ground in two sections, one for maximum and the other for minimum limits. A practice is followed which we think could be more generally adopted to advantage and that is of cutting spiral oil runs on the spindles and shafts of the machines, with simply a straight groove across the bottom of the box. The grooves of the shaft revolve with the latter and carry the oil better than the stationary grooves of the box, and, moreover, are not as likely to clog.

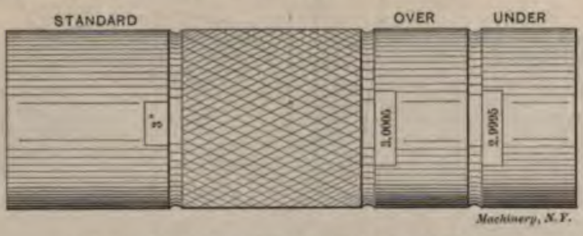


Fig. 10. Combined Standard and Limit Plug Gage.

### The Use of Jigs.

A fixture for a horizontal boring mill is in use which, while simple and probably not new to most shops, is well worthy of attention. A bracket B in Fig. 11 is to have holes bored at a and b which must be located in certain definite positions. The base of B is made with a tongue which fits one of the T-slots in the boring machine table and also a corresponding groove in the frame of the machine of which it forms a part. The fixture consists of the two uprights, A and C, with their bushings, which serve as guides for the boring bar. These uprights are tongued to fit the T-slot of the table, and thus can be correctly located at once with the bracket B. Instead of having to lay out the holes in the bracket and set the bar as nearly as may be by trial, the holes can be easily bored without laying out by using the bearings in the uprights for the bar.

This plan of using tongues and grooves for locating parts of machinery on the machine frame or for setting a jig in the right relative position with the piece upon which work is to be done, is susceptible of extended application. The principle is useful in planer work where a gage for setting the tool may be set by one of the T-slots in the planer table, and the work located by the same slot and at the Bullard works many pieces are planed in this way.

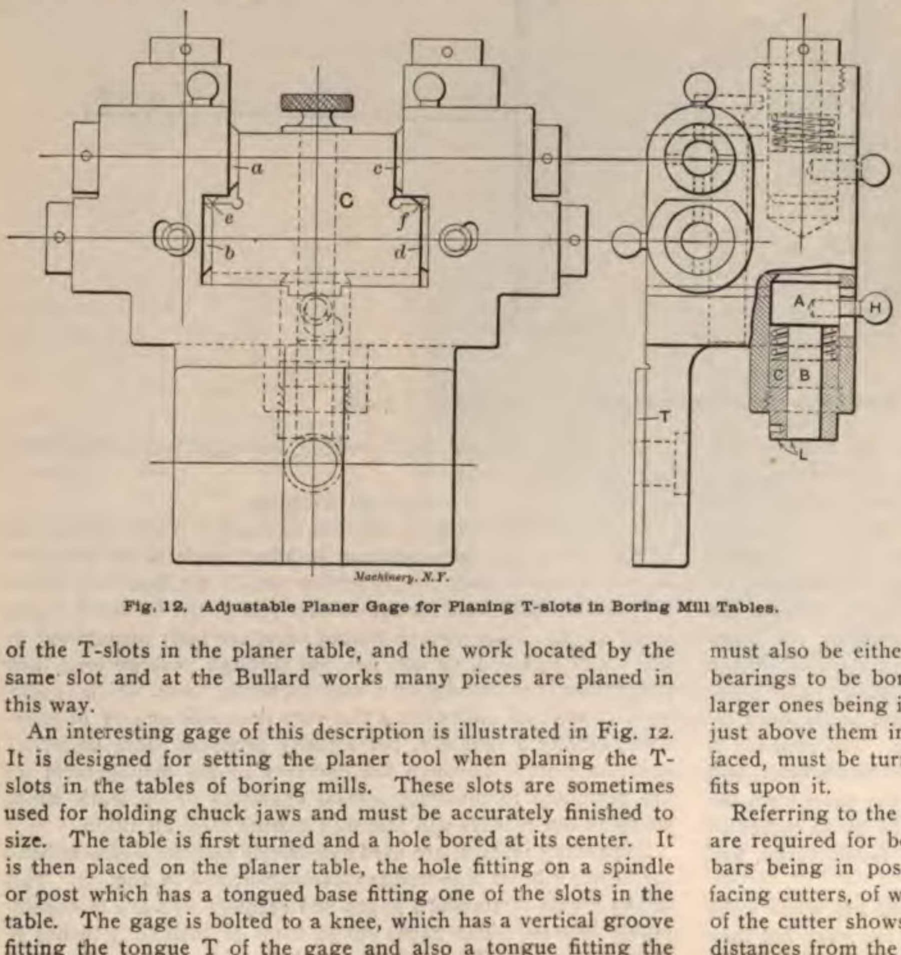


Fig. 12. Adjustable Planer Gage for Planing T-slots in Boring Mill Tables.

An interesting gage of this description is illustrated in Fig. 12. It is designed for setting the planer tool when planing the T-slots in the tables of boring mills. These slots are sometimes used for holding chuck jaws and must be accurately finished to size. The table is first turned and a hole bored at its center. It is then placed on the planer table, the hole fitting on a spindle or post which has a tongued base fitting one of the slots in the table. The gage is bolted to a knee, which has a vertical groove fitting the tongue T of the gage and also a tongue fitting the planer slot. G is a test gage of the exact form of the slot to be planed and it is used for adjusting six hardened pins, a, b, c, d, e and f, of the planer gage. A section of one of these pins appears in the right-hand view. It consists of a head A, and a smaller neck or spindle B, which is free to slide in a bushing C. The coiled spring always tends to force the pin inward and in adjusting the pin its face is allowed to bear against one face of the gage G. The bushing C is then screwed out or in until its outer end is even or flush with the end of the spindle B at L, as determined by the sense of feeling with the finger tip. Having thus adjusted all the pins, the process of setting the planer tool to any one of them is simply to bring the tool against the face of the pin and move the tool until the ends of the pin spindle and the bushing are even. To avoid injury to the pins, by the tool over-running when the planer is in operation, there is a handle H which serves to move the pin back out of the way and by turning slightly the handle will catch in a slot and retain the pin.

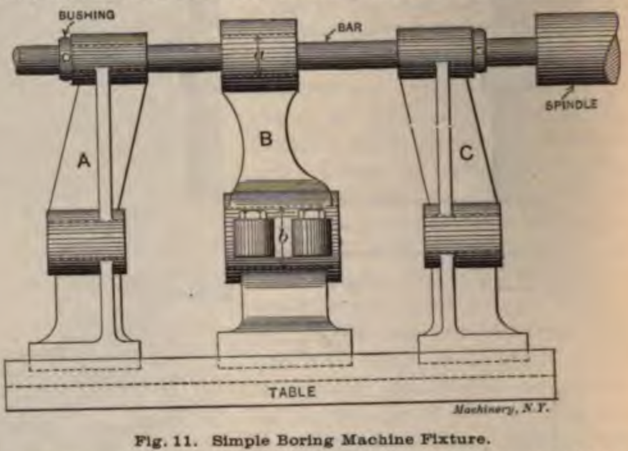


Fig. 11. Simple Boring Machine Fixture.

There are two more examples of jig work that we will refer to, one of which is illustrated in Fig. 14. This represents a drill-press fixture for boring, facing and reaming the bearings in a casting that contains the feedworks for one spindle of a boring mill. There are two sets of three holes each, which must be bored and reamed in line, with the two lines of holes parallel and a definite distance apart. The photograph shows the fixture, with the casting in place and with two bars in position, on each of which is a set of shell reamers.

The other example is of the same character, but is more elaborate. There are more operations to be performed upon the piece, and the fixture together with the bars, cutters, reamers, etc., make as elaborate a set of tools as will often be found for work of this size and character.

To fully understand the operations to be performed in this fixture, reference must be made to the castings on the truck in Fig. 15. This illustration represents a top and bottom view of a casting for the driving mechanism of a boring mill. The surfaces A A of the flange are first planed, these being the surfaces upon which the casting rests when in place on the mill. All the other operations are performed in the fixture in Fig. 16, the casting being supported in the fixture by the planed surfaces of this flange. There are seven holes to be drilled in the flange, which must also be either countersunk or spot faced. There are four bearings to be bored, reamed and faced on their ends, the two larger ones being in the hubs B and C and the two smaller ones just above them in the photograph. The hub C, besides being faced, must be turned on the outside to receive a trunnion that fits upon it.

Referring to the tools in Fig. 16 it will be seen that seven bars are required for boring, facing and reaming, one of the boring bars being in position. At the left is a pile of inserted-tooth facing cutters, of which one is in the foreground at A. This view of the cutter shows that there are four inserted teeth at different distances from the center, so that the full width of the hub to be faced will be covered. These cutters are employed for roughing

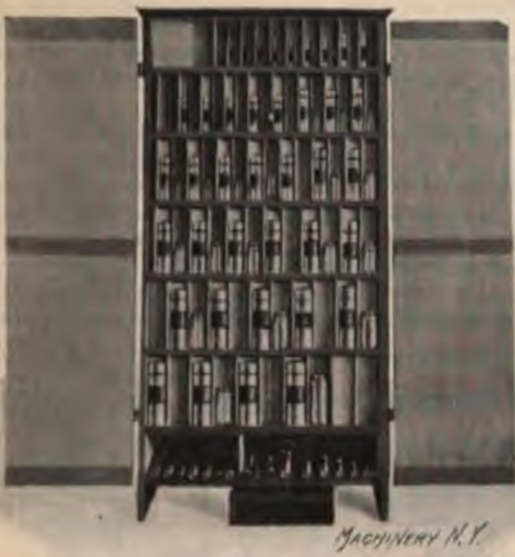


Fig. 13. Cupboard of Gages and Standard Reamers from 1-2 inch to 3 inches.

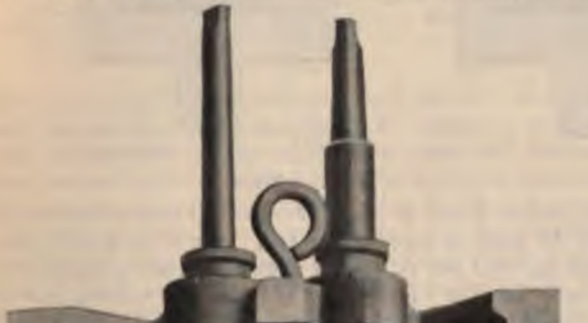


Fig. 14. Fixture for Boring and Reaming Feed-works Casting.

out, and on top of the fixture is a set of cutters used for finishing. At B is one of the cutter bars used for facing and it is threaded at its upper end for the stop C, which gages the depth to which the facing tool can operate, and which can have any adjustment desired by turning one way or the other. At D are the two cutters and holders used for turning the outside of the hub C, in Fig. 15.

* * *

### SPRING MEETING, A. S. M. E.

The spring meeting of the American Society for Mechanical Engineers will be held from May 15th to 18th. The following papers will be presented at the different sessions:

Wednesday morning, May 16th: "On the Value of a Horse Power," by Geo. I. Rockwood; "Hot Water Heating from a Central Station," by H. T. Yaryan; "Systems of Efficiency of Electric Transmission in Factories and Mills," by W. S. Aldrich; "Design of Speed Cones," by J. J. Guest.

Wednesday evening: "Multiple Cylinder Engines," by Robt. H. Thurston; "The Gas Engine Hot-tube as an Ignition Timing Device," by Wm. T. McGruder; "Water Softening Plant of the Lorain Steel Co.," by N. O. Goldsmith; "Education of Machinists, Foremen and Engineers," by M. P. Higgins.

Thursday morning, May 17th: "The Automobile Wagon for Heavy Duty," by Arthur Herschmann; "A Test of a Fifteen Million High Duty Pumping Engine at Grand Rapids, Mich.," by M. E. Cooley; "Tests of the Snow Pumping Engine at the Riverside Station of the Indianapolis Water Company," by W. F. M. Goss; "Cylinder Proportions for Compound and Triple Expansion Engines," by B. C. Ball.

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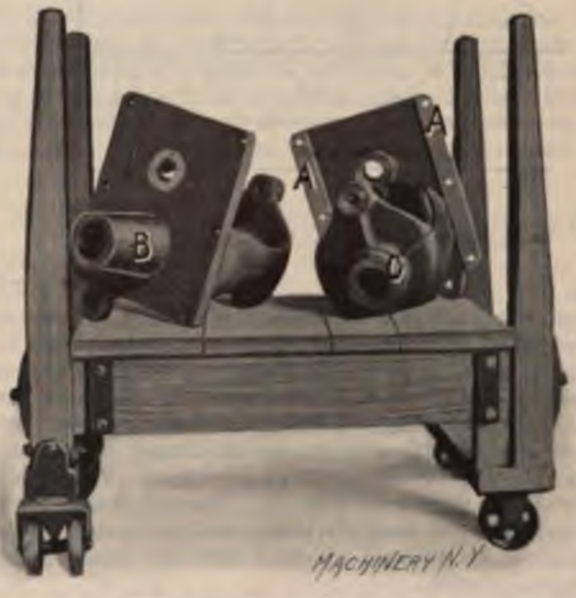


Fig. 15. Views of a Casting for which the Fixture in Fig. 16 is Used.

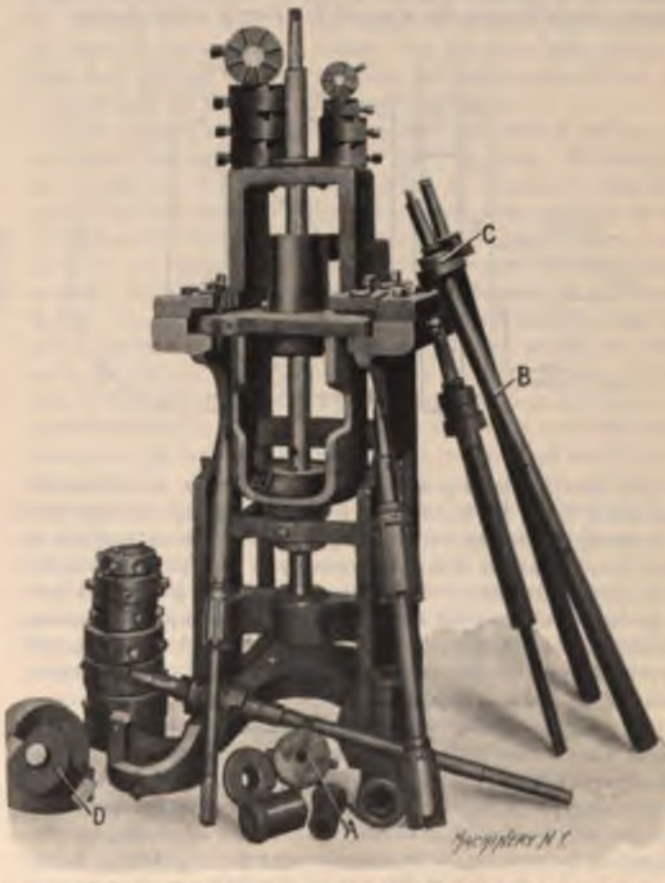


Fig. 16. Fixture for Boring, Facing, Turning and Reaming a Casting containing the Driving Mechanism for a Boring Mill.

## EPICYCLIC GEARING.—2.

### APPLICATIONS IN SPUR GEARING.

Those who were subscribers to MACHINERY last August will remember an article that was published in that number treating of the principles of epicyclic gearing and giving directions for calculating the forms of such gearing that most often occur. In this and a subsequent number we shall illustrate a few applications of epicyclic gearing to actual practice, showing a number of cases where it contributes largely to the success of the machines upon which it is used.

The writer has questioned the recent graduates of a number of colleges of engineering as to the instruction given in this subject, and from their apparent unfamiliarity with it, it would seem that epicyclic gearing were not receiving the attention that it deserves. Certain recent text-books upon mechanism contain little or nothing upon it. Kent's pocket book does little more than to define epicyclic gearing, and there seems to be a general lack of material and instruction concerning this branch of mechanism, that is quite disproportionate to its importance. This is doubly true in view of the comparatively large amount of attention paid to some of the less necessary branches of mechanism, like parallel motions, for example, which are practically obsolete, except in indicator practice.

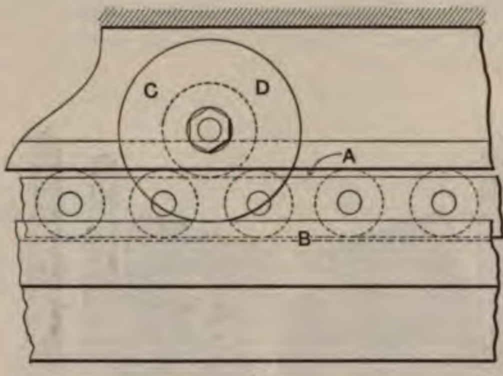
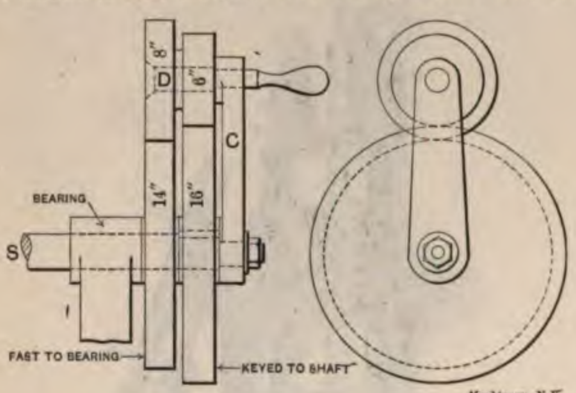


Fig. 2.

Epicyclic spur gearing has been used in several forms, beginning with the time when James Watt employed the sun and planet wheels to take the place of the simple crank motion. It is now used for back gearing on machine tools, for hoists, for drill-press feeds, for boring-bar feeds, for driving the type beds of printing presses as well as for controlling certain motions on these presses; and it is used extensively in rope and cable laying or winding machinery. There are many places where this form of gearing could be used successfully, as for example, in securing velocity ratios difficult to secure by ordinary trains. Thus, with a reverted train of four gears with 51, 50, 49 and 50 teeth respectively, a ratio of 1 to 2,500 is secured.



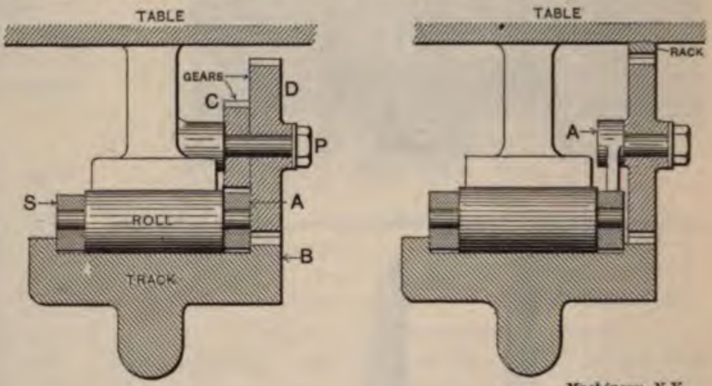
*Machinery, N.Y.*

Fig. 1.

The epicyclic bevel-gear is even more useful than the spur-gear train. One of its earliest applications was to cotton spinning machinery, where it marked an important advance in this class of machinery. It is still used extensively in textile machinery, and has also been applied to water-wheel and steam-engine governors, to dynamometers for the measurement of power, to motor carriages, tricycles and shafting as an equalizing mechanism, and to electric cranes for the same purpose.

In what follows no attempt will be made to refer to more than a few of the different arrangements and uses of epicyclic gearing and devices will be mentioned from among those that have actually come under the writer's observation.

About 15 years ago Mr. Chas. E. Barrett, an ingenious mechanic in Vermont, was engaged in building paper machinery, and among the novel devices that he applied was a crank motion, similar in principle to that shown in Fig. 1. The motion was used for turning a reel on which rolls of paper were supported as the paper was delivered from the machine. The usual custom was to turn the reel when it was desired to change from one roll to another, through a pinion and large spur gear, which gave enough reduction so that the reel could be easily turned by hand.

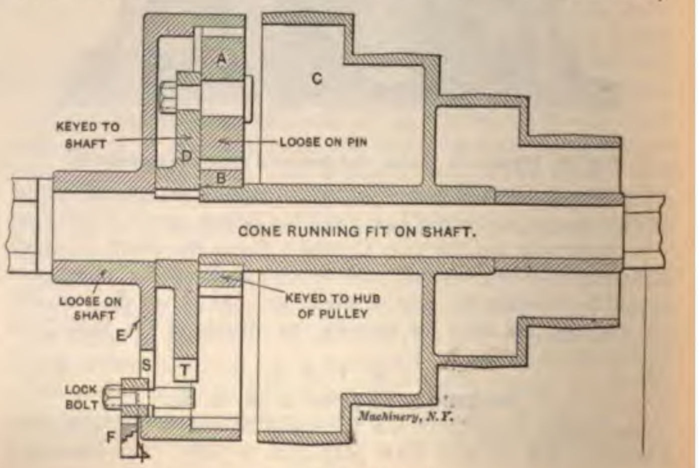


*Machinery, N.Y.*

Fig. 3.

In the device shown in Fig. 1 the crank C is loose on the shaft S, but the latter is keyed to the reel. The 6 and 8-inch pinions are fast together and turn freely upon pin D, which is attached to the crank C. The 14-inch gear is fast to the bearing and does not turn, while the 16-inch gear is keyed to the shaft. When the crank is turned the pinions not only turn on their pin D, but revolve about the 14- and 16-inch gears. If the gears were all locked together and were free to turn about the shaft with the crank, the shaft would turn once for one turn of the crank; but having performed this operation, we have turned the 14-inch gear, when in reality it is stationary. Hence, the final motion will be as though the arm were held stationary and this gear were turned back once, which will cause the 16-inch gear and the shaft to turn $\frac{21}{32}$ times. This deducted from the one turn when all wheels went with the arm gives $\frac{11}{32}$ turn as the final result.

If, in Fig. 1, the diameters of the 14- and 16-inch gears be so increased that their radii are infinite and they become racks, while the pinions attached to the crank have a motion of translation instead of revolving about the shaft S, a mechanism will result similar to that shown in Fig. 2. This device has been applied to printing presses for controlling the motion of the frame carrying the rollers upon which the type table travels. The type table of a flat-bed press reciprocates and instead of sliding in V's like those of a planer, is made to run on rollers, to reduce the friction. These rollers are kept equidistant by a frame, and it is clear that rollers and frame should move back and forth just half as far as the table moves. To compel them to do this, and to prevent the rollers working backward or forward so far as to strike the ends of the track, a rack is attached to the track at B



*Machinery, N.Y.*

Fig. 4.

and another to the frame at A, into which the pinions D and C mesh, respectively. These pinions are fast to each other and travel with the table, and at the same time turning upon the pin P. As D is just twice the size of C, it is clear that the rollers will be driven just half as far and half as fast as the table moves.

A simpler arrangement for producing the same result is shown in Fig. 3, where only one gear is used, but it travels with the rollers instead of with the table, and runs in racks on the table and on the track.

There are several arrangements for back gears whereby all the gearing is encased within the cone. Some of these are epicyclic in their action and some are not, but in Fig. 4 is a sectional view of an epicyclic back gear that has been applied by the Betts Machine Co. to their radial drills. The cone, C, runs loose on the shaft, the lock-plate is keyed to the shaft, carries a pin on which the pinion A turns and has a slot at T. Pinion A meshes in a pinion B keyed to the hub of the cone pulley and also meshes with internal teeth cut on the inner periphery of the plate E. This plate is loose on the shaft and has a slot at S, in which slides the lock bolt. It will be observed that the lock bolt extends through plate E, so that when it is slid in the slot S toward the shaft it will engage in the slot T of the lock-plate D. In this position the whole system is locked together so that the cone turns the shaft. If the lock bolt be lowered, or moved away from the shaft so that its washer fits in the slot of a projection of the frame F of the machine, plate E will be kept from turning and will act as a fixed internal gear for pinion A. As cone C turns, it will drive pinion A through pinion B, and D will turn, together with the shaft, at a slower speed than the cone.

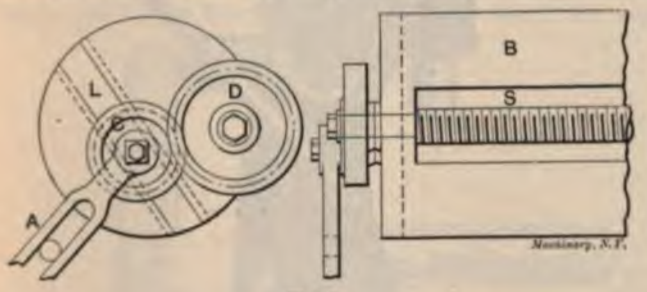


Fig. 5.

In Fig. 5 is an application of Watt's sun and planet wheel, although for quite a different purpose than that for which James Watt originated the device. The application shown is for a boring bar feed, where the bar is supported in bearings and the cutter head is fed along the bar, as the latter revolves, by a feed screw and gearing. In the sketch B is the bar, S the feed screw, and C and D the two gears that give motion to the feed screw. Gear D is attached to the end of the feed screw and C, which meshes with D, is prevented from turning, as the bar rotates, by the slotted link or crank A, which slides upon a stationary pin. In the end of the bar is a dove-tailed slot, L, for adjustment of the pin on which C turns, so that gears of any size can be used.

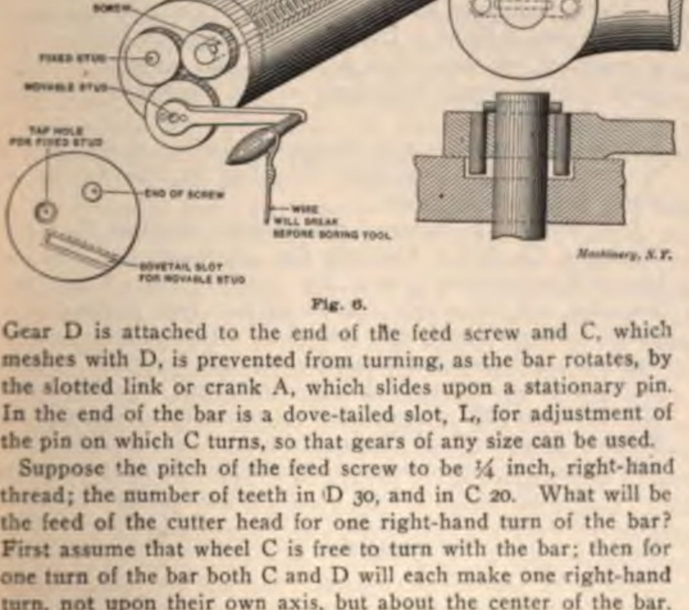


Fig. 6.

Suppose the pitch of the feed screw to be ¼ inch, right-hand thread; the number of teeth in D 30, and in C 20. What will be the feed of the cutter head for one right-hand turn of the bar? First assume that wheel C is free to turn with the bar; then for one turn of the bar both C and D will each make one right-hand turn, not upon their own axis, but about the center of the bar. We have done with C, however, what was not desired, viz., given it one turn, and hence must now move it back one turn, the bar being stationary. Wheel D and the screw, therefore, will be moved ahead 2-3 of a turn during this operation, which, added to the one turn previously made makes 1 2-3 turns for the screw, to one turn of the bar. The cutter head would thus be fed 1 2-3 × ¼ inches were it not for the fact that the nut in the head, which fits the feed screw, also makes one right-hand turn for each turn of the bar. The actual feed, therefore, is only 2-3 × ¼ = 1-6 of an inch, and the feed is toward the left in the sketch. To reverse the feed it is simply necessary to introduce an idler gear.

In Fig. 6 are details of a boring bar feed upon this principle in use at the Builders' Iron Foundry, Providence, R. I. The lettering upon the sketch will make the construction quite clear. There is an idler gear to give feed in the opposite direction from Fig. 5. The wire attached to the crank keeps the lower gear from turning and the slot for the movable stud in the end of the bar permits the use of change gears. At the right are details of the crank.

In the February, 1900, number of the paper was shown a novel drill-press feed through epicyclic gearing that the writer found in a New Hampshire shop and which may be of interest to refer to in connection with the examples just cited. With these few and simple illustrations we will drop the subject of epicyclic spur gearing, leaving epicyclic bevel gearing until another time.

* * *

## THE FUTURE OF THE IRON FOUNDRY.

In a lecture delivered before the students of engineering at the Cornell University, Mr. William Kent reviewed the main features of the manufacture of iron and steel at the present day and at the close touched upon the future of this industry. He said it would seem as though the art of the engineer or inventor could go but little further in improving the methods of manufacture of steel, from the mining and transportation of the ore to the delivery of the finished product in shapes as fine as wire or nails. Everything seems to be so well done by machinery now that there is but little margin left for further saving.

The case is altogether different, however, in the manufacture of castings from cast iron. The method commonly used, that of the cupola furnace, is that of two or three centuries ago. As the 700 blast furnaces in the United States in 1873 have been replaced entirely by half as many, each one making on an average 12 times as much iron, so the thousand or more cupolas should be replaced by something better. Its use is to take good pig iron, and at great expense of labor, fuel, and waste of iron, put sulphur into the iron and deteriorate its quality.

Some day some enterprising capitalist will build a million dollar foundry alongside of a pair of blast furnaces. He will have no cupola, but he will get one grade or quality of iron from one of his blast furnaces and another grade from another, at will. A third grade he will get as desired from a Jones mixer, a two hundred ton brick-lined vessel, heated by gas on the Siemens system. Still other grades he will get, if desired, in gas heated ladles, where the metal may be treated chemically, and any grade needed for special purposes, such as car wheels or chilled rolls, he will get from a reverberatory Siemens furnace. There will be no pig iron about the place, except such as is made to be sold, or is used to change the grade in the mixer or in the reverberatory. As far as possible the metal will be used hot from the blast furnace. There will be an immense pattern storehouse, built in detached parts, where patterns will be stored from all over the country, and the foundry will have also its own patterns of standard articles, such as engine bed plates and cylinders, foundation plates, columns, etc. When such a foundry is in operation it will wipe out of existence fifty or a hundred of the small cupolas which are cumbering the ground, and a revolution will take place in the foundry industry similar to the one that began in the blast furnace industry in 1870. Here is the work for the coming generation of mechanical engineers, to put the foundry on the same grade scientifically and economically, as the blast furnace now is. All that is needed now to start this improvement is the willing capitalist, or perhaps the promoter, who knows how to show the capitalist "there's millions in it," and I do not think this greatly needed improvement in the iron industry can be much longer delayed.

## ITEMS OF MECHANICAL INTEREST.

### GLEANED FROM VARIOUS SOURCES.

An interesting feature of the General Electric Works at Schenectady for the bicyclist, is the immense storage sheds for the accommodation of the employees who ride to the works on their wheels. The sheds have storage room for 1,500 bicycles and for a small sum per week the wheels are kept in running repair, well cleaned and lubricated. It is unnecessary to say that the idea is a popular one with the employees, as the pleasure of having their wheels always clean and in good running condition is well worth the required expenditure.

A correspondent to a contemporary gives a recipe for cleaning rusted tools which may be valuable, but we cannot vouch for its efficacy.

If the rust be heavy, stand the tools in coal oil for a few hours, but if only slightly rusted this is not necessary. Next dip the articles in liquor potassa for a few moments and then put them into a strong solution of potassium cyanide. Remove from the solution; clean with a paste of the cyanide, castile soap, chalk and water; rinse and place in a saturated solution of chloride of tin and leave over night.

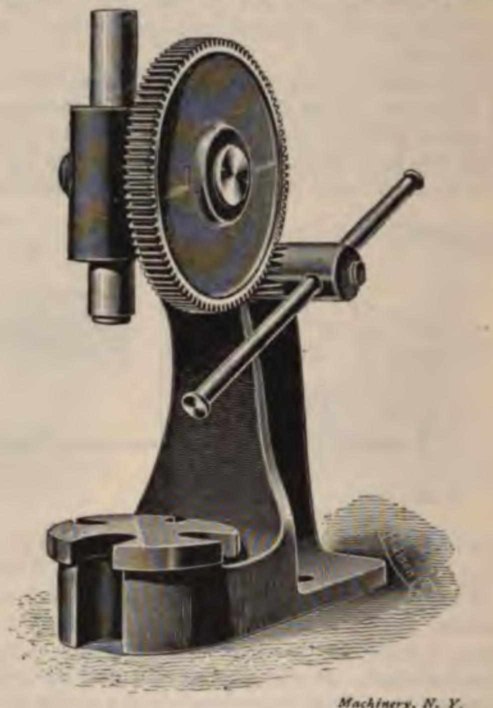
The Paris Exposition opened on April 14th, with impressive ceremonials. President Loubet formally inaugurated the Exposition, but it will be some time before it becomes an exposition in fact as well as in name. Many of the buildings have not yet been completed, and many of the exhibits are yet to be placed in position. The American exhibits are comparatively well forward. The exhibit of machinery for this country has suffered, of course, because of the loss of the machinery that was being transported on the vessel Pauillac, but every effort has been made to get the remainder, which constitutes by far the larger portion, unpacked and in place even though it is not in working order. In the next month's issue we hope to be able to report further advance and possibly give some definite information about the general character of the display.

What appears to be an absurdity in the development of the automobile, is reported as being experimented with in France. A trolley line has been constructed in the suburbs of Paris which consists of two wires so arranged that a small trolley car can be carried on them, the two wires forming a track. This arrangement is expected to furnish power to automobiles, each of which will be provided with a flexible connection to its individual trolley. To clear obstructions and other vehicles, the automobile will carry a vertical pole to the upper end of which will be attached the trolley connection. The idea then simmers down to a street car line in which the cars run on the ground instead of steel rails. While the line proposed may be a success under certain local conditions, it would appear that if there is no better solution of the power problem for the automobile than this, its development might as well be abandoned.

A stop-valve or cock in a steam gage pipe is often quite a convenience but is likely to be a dangerous trap and should never be allowed. An instance is known where a disastrous explosion was narrowly averted by the prompt action of a machinist in a railway shop, the cause being a stop cock located as mentioned. A locomotive was being fired up for the preparatory work necessary before going on the road. The safety-valves had been overhauled and were in consequence not set to any particular pressure, the springs being set to a tension that was sufficient to restrain a pressure of perhaps 100 pounds. The attendant who was fitting up the engine complained that he could not get any steam pressure after having a heavy fire going for an hour or so, the steam gage only indicating about 40 pounds pressure. A machinist who looked after the valves and gages took in the situation at a glance and turned the stop cock in the gage pipe when the pointer instantly flew around to 240 pounds and struck the stop pin with a peculiar "ping." The fires were hauled as quickly as possible and the springs on the safety valves cautiously loosened until some of the enormous excess pressure was reduced. After the boiler had cooled down an examination showed that apparently no damage had been done but the lesson was sufficient for one man at least to last him through life.

### AN ENGLISH ARBOR PRESS.

It is quite evidently shown by the accompanying cut reproduced from an English contemporary, that the Britons appreciate the merits of the arbor press as one of their enterprising manufacturers is now making it in this form. The description states that "it is a mandrel press designed to supersede the method of forcing in mandrels by hammering. Its use insures good work by keeping the mandrels in good condition, and is a most useful labor-saving tool."


*Machinery, N. Y.*

If the press, as made, be copied from the one that has become so popular in this country, we do not think that the British manufacturers have improved it, either in appearance or utility. It will be noticed that the press not only has no quick return, but the operating lever offers a varying turning moment to the operator, much to his disadvantage.

* * *

## OBITUARY NOTES.

Waterman C. Bradley, member of the Bradley Co., manufacturers of the Bradley hammer, Syracuse, N. Y., died on March 31st at the age of 68.

Andrew D. Cramp, son of William Cramp and formerly superintendent of the Cramp shipyards, died March 29th, in Boston, aged 43 years.

William S. Doig, the inventor of box-nailing machinery, died on March 20th, aged 52. Mr. Doig was at one time connected with the firm of Smith & Doig, who manufactured various styles of machines, but later, when he became sole proprietor, he devoted himself almost exclusively to the manufacture of box-nailing machinery.

Stephen Tasker, a son of Thomas T. Tasker, of the firm of Morris & Tasker, Newcastle, Del., died in Philadelphia on March 19th, aged 65 years.

J. R. Stewart, president of the Bradford Machine Tool Co., Cincinnati, O., died in Riverside, Cal., on March 31st. He was born in Westmoreland County, Pa. He held the office of first lieutenant and afterwards captain of the 17th Regiment, Indiana Artillery, during the Rebellion. In 1870 he moved to Cincinnati, and connected himself with James Bradford, founder of the present company. He was president of the Bradford Mill Co. from 1885 to 1900, when the name was changed to the Bradford Machine Tool Co., at which time he was made president of the new corporation, which office he held until his death.

Mr. Stewart was prominent in all business circles in Cincinnati, was a mason and member of the Loyal Legion of Ohio. His wife, son and two daughters survive him.

Austin W. Goodell, of the firm of Goodell & Waters, engaged in the foundry and wood-working machinery business in Philadelphia, died on April 15th, aged 68.

## THE EVOLUTION OF ARCHIMEDES.—2.

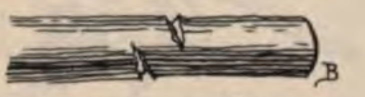
### A TRUE BIOGRAPHY.

JUNIUS.

There was one machine in Bang & Ammer's shop which Archimedes will remember until his dying day—a horizontal traverse drill on a rather low bed, so that the spindle was only about two feet from the floor, used for drilling heavy work. Once upon a time our friend had the belt upon the biggest step of the cone and a big flat drill slowly revolving with the spindle. He found that the work was not quite high enough, and carelessly leaned over the machine to pick up a wedge from behind. He felt something suddenly grab the loose front of his blouse and begin to pull. Harder and stronger pulled the big drill, and tighter and tighter drew the girdle around his waist. He tried to cry out to a shopmate at work near by, but he could not make a sound. Things began to look black, when, with a last despairing effort, he thrust the big wedge under the belt and threw it from the pulley. They unwound him by turning the drill backwards. Did you ever see the long, flowing beard of a machinist catch on a rough piece of steel which he was turning in the lathe? No? Well, let us hope you never will. Speaking of this same traverse drill—it had a long belt, running from the cone pulley up to the counter overhead, in a slanting direction. It used to be a favorite amusement with the boys to put the belt on the slowest speed and then catching hold with both hands, to let the belt pull them up from the floor a few feet, when they would let go and drop. It was a dangerous experiment, for it takes a deal of will power to make you let go in such a case, and the higher up you get, the more you hate to drop. Once Archimedes got his fingers almost under the belt on the upper pulley before he realized the danger. He dropped about six feet and struck on the floor with a shock which seemed to drive his backbone right up through his crown. But he thinks, what if he had not let go? There was no tool-room in the shop. An inclined shelf over the bench at the north side of the room, carried an assortment of flat reamers made by one of the proprietors at some remote period. Under the same bench, on a shelf and on the floor, was a miscellaneous collection of arbors or mandrels, made of soft iron badly grooved and nicked by the points of side tools, during the squaring up process. Here and there a hand or a lathe reamer made for some special job, perhaps in a drawer or on a shelf. If it was a taper reamer, as many of them were, a wrought iron collar shrunk on, said: "Thus far and no farther."

T. Aper Reamer, Esq.

Fig. 1.



How to cut off round iron

Fig. 2.

Archimedes' first experience in "chucking" a piece, as it was called, consisted in steering the point of a flat drill, held by the tail center of the lathe and a steady rest, at the center of the rapidly revolving casting, worrying as it wobbled and cheering up as it gradually steadied to its work; then, after the drill was through, following it up with a rose reamer, held in the same manner, and cutting a hole whose size depended entirely on circumstances. Archimedes took the casting out of the chuck, usually burning his fingers in the process, and tried the hole to see if it was "jest a little strong five-eighths" (which it generally was). If the hole was to be a taper, it was finished with a taper reamer wearing a turn-down collar, as before mentioned. This same lathe, by the way, had a chain feed, and when Archimedes took to turning, some later in the course, he soon learned that after setting the tool and connecting up the feed, he would have plenty of time to go to lunch and be back before the tool began cutting. Turning in those days meant turning iron and not steel; very little steel was used except for tools, and soft, or machinery steel was comparatively unknown.

When Archimedes got his first order to turn up some iron shafts, he felt so large that his hat-band cracked. To measure off the iron, to have another man to help him cut it with sledge and cold-chisel, to hold the chisel himself and make the other fellow do the striking—all this was rapture. At first he managed to hold the chisel askew and cut a fine spiral on the round iron, and he trembled a little when the sledge came down. The centering, the straightening, the squaring-up were all tantalizing preliminaries to the final delight of sitting still and seeing the lathe do the work. The pattern was a hard-wood stick with certain cabalistic notches to indicate bearings, taper fits, screw-threads, etc., and marking was done with a file on the rough iron. If the lengths came within a sixteenth, it was close work. As to sizes, well, if it was a journal, Archimedes set his calipers to a "scant five-eighths" on his steel scale, by thumping them on the edge of the tail stock, and turned the iron by them. And, oh! the sandy seams in that iron, the springing of it, and the shaving which got in the center at the finishing chip, and the filing to bring it to size! He tried it finally by one of those same cast-iron boxes which he had chucked, and as it did go in and did not rattle very bad, he ventured to show it to Ammer. Ammer "guessed it would do, but you might make the others just a shade larger." The limit of error in a country job-shop is either a "shade" or a "hair." The day of the snap gage or the hardened plug and collar was not yet. But when the lathe went well and while the chain feed was catching up, Archimedes started to make some tools for himself, which was one of the unwritten privileges of the shop. He cut a pair of calipers of fantastic shape out of sheet steel, riveted them together and spent all his spare moments filing them and rubbing them with emery cloth. Old Carl made him a hammer, and he drilled and filed and polished this until it was ready to harden. And so on, with chisels, gages, scribers, etc., until his tool drawer was filled with a motley assortment.

One day Ammer came to him with a new job, a shaft or arbor to be turned and to have fastened on it two cast-iron hubs or flanges. Ammer said they must be shrunk on. Archimedes did not know exactly what this meant, but he shrank from saying so. He went to a shopmate and asked him about it. The man said: "Oh, you bore the flanges a little small, heat 'em, slip 'em on and jest let 'em cool. It's dead easy." "But how much small?" persisted Archimedes. "Oh, jest a hair, jest so they won't slip on." "And how hot do they want to be?" "Jest a dull red sos't you can see it." Archimedes concluded it was all a "jest," but he soon learned better. He turned his shaft, and bored his flanges "jest a hair" small as near as he could estimate, and satisfied himself that they would not slip on. He then built up a roaring fire on the spare forge and laid one of the flanges carefully over the hot coals. After watching it a few minutes, he went into the shop to get the shaft. When he returned something was amiss. The hub was on the fire red-hot, but nearly half the flange had disappeared. And thus Archimedes learned how to melt cast-iron.

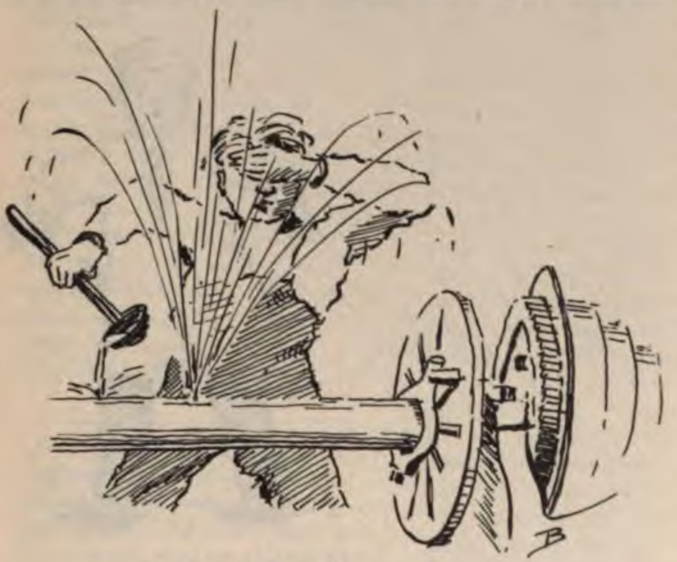
The Width of a Door

Fig. 3.

Nothing to do but to wait until they cast again at the foundry and then bore out another flange. This time better luck, and the flange was heated uniformly to a dull red, the shaft fastened in a vise near by and the flange started carefully on. Methinks, though, the "hair small" must have been a coarse one, perhaps of the blacksmith variety, for when about half way, the casting goes slower, hesitates, and "who hesitates is lost" on a shrink fit. Yes, it has "stuck" about half an inch from home and a big lump sticks in Archimedes' throat the rest of that day.

Notwithstanding his various mishaps, Archimedes is slowly but surely advanced from little to big and from simple to complicated jobs. Some of the jobs in a country shop are pretty complicated and require a deal of ingenuity and close thinking. There are no special tools, no jigs and templates to work by. Never a job just like the present one before and probably never will be again. Make your own face-plate and chuck, your own drill and reamer, block up the headstock if the lathe be too small, and run the tailstock out on blocking if the ways be too short. Anything to get there. And what a lot of moral courage it takes to make a big fit by calipers when there are no gages. There is the big pulley or gear on the floor with the hole bored to some size which cannot be stated in inches. Here is the big shaft in the lathe ready for the finishing cut. You set the springy inside calipers or perhaps file a wire to fit the hole and wag them back and forth and twist them around until you think they just touch. You lay them on the bench with the points projecting over and try to fit the equally springy outside calipers to them. Then you try to remember just how tight the inside calipers fitted the hole and just how tight the outside fitted the inside, and compare these vague memories with the feeling of the shaft under the calipers. You try the hole in the wheel a dozen times, you change your calipers a little each time, and your memory and your judgment seem more unreliable each time. You feel like the English carpenter who tried to go through London streets with the measure of a door between his hands. And, oh! the terrible, sickening anxiety when you first try the shaft in its place, for fear it may slip in up to the shoulder and then "wobble!" Of course, the chances are that it will not go in at all, for you have been scared and nervous all along and have not dared to trust your own measurements.

Archimedes will never forget one experiment of his with a big cast-iron shaft. I think he managed the turning all right this time and made no serious blunders. But when the shaft came from the foundry there were one or two places in it that looked rather worm-eaten. Ammer said babbitt them and Archimedes had no choice but to obey, although his conscience troubled him a bit. He got the shaft on the centers in the big lathe and turned the biggest blow-hole uppermost, then went to the blacksmith shop, hunted up the ladle and some loose pieces of babbitt. It did not take long to melt the metal, to carry it to the lathe and to pour a table-spoonful into the hole. But as luck would have it, the shaft had lain out of doors several days, and tucked away in the corner of this hole was a drop of water. When he saw the hot babbitt coming this drop just arched his back and spit, for all the world like an angry cat, while Mr. Babbitt backed out in a hurry. Archimedes got most of the charge in his face, and for a few minutes looked like a silver-plated teaspoon. Fortunately, he shut his eyes in time, and after his mate had peeled off the plating, he was not much the worse for wear. Archimedes always regarded this as a judgment, but he could not see why it should have hit him instead of Ammer.

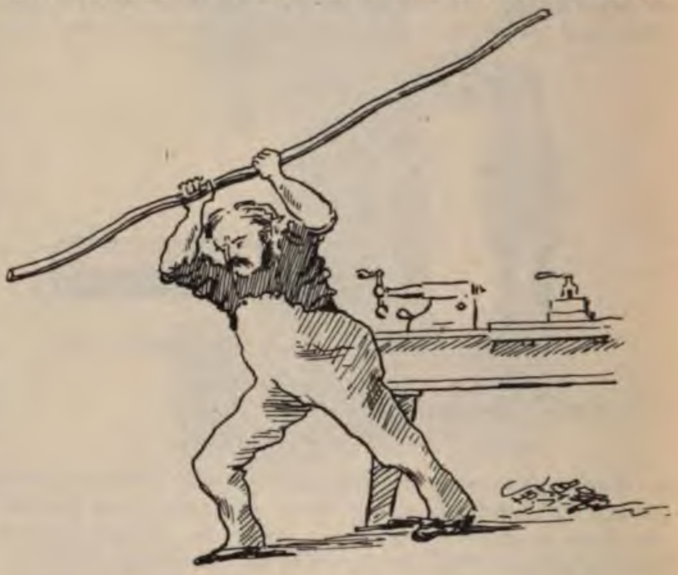


Silver Plating

Fig. 4.

Speaking of babbitt, why "babbitt," what is babbitt and who was Babbitt? Was he the soap man, and why did he invent and give his name to this nondescript hybrid among metals? Old Carl, the blacksmith, had a very poor opinion of this particular metal, for every journeyman and apprentice melted babbitt at the forge and managed to spill some in the process. In time the tuyere would get pretty well plugged and Carl would have to go into the mining business.

There was a journeyman in the machine shop whom we will call George. Now, George was of a rather irascible temperament and would let his angry passions rise on very slight provocation. It so happened that he was instructed to straighten and turn a piece of two-inch iron shafting some ten or twelve feet long. Quite recently he had learned that if a slack place in a shaft was pened with the round end of a hammer, the metal would be drawn out and the shaft straightened at that point. He had not learned that such conversion was only skin-deep. This was a very crooked piece of iron with many short yanks in its length. George centered it with care, squared up the ends and proceeded to correct the yanks by wedging up under them and pening the concave side. After a patient, faithful treatment he in time got the iron tolerably straight. He then adjusted his steady-rest and collars, his roughing tool, his finishing tool and his drip of soapy water, and proceeded to turn the shaft in the highest style of the art. As he went along he noticed that the turned portion acted rather funny, but he had been out late the night before and thought the trouble must be in his eyes. And now the turning is done and George removes the restraining rests from the shaft and speeds up the lathe "to see how she runs." Well, she ran like an animated cork-screw.



Straightening Shafting

Fig. 5.

Archimedes heard an oath, a ripping and smashing and looked around just in time to see the shaft flash through the air, thrown by the muscular arms of the angry lathesman and fall writhing upon the floor like a wounded snake. Archimedes retired to a pile of shavings in the planing mill, where he could have his laugh out unobserved, and when he returned he found the somewhat sobered George going through another pening process on the turned shaft.

* * *

Malleable cast iron is a metal obtained from fine-grained cast iron of good quality, from which certain quantities of carbon have been removed in the process of its production. The lower the carbon, the softer and more ductile is the metal and malleable iron, being lower in carbon than gray cast iron, is better able to withstand blows and shocks without breaking. The decarburization is accomplished by packing the castings in some oxidizing agent, like hematite or rolling mill scale. The carbon of the iron then unites at the high temperatures to which the iron is subjected, with the oxygen of the agent, forming carbon oxide.

## THE CONVERSION OF FORMULAS.

### FROM METRIC TO ENGLISH UNITS—PRACTICE FOR THOSE VERSED IN ALGEBRA.

J. J. C.

To be able to convert a formula from one system of units to another system of units, readily and accurately, is an accomplishment that few people—even engineers and mathematicians—possess. The widespread adoption of the metric system by scientists and foreign countries, makes it frequently necessary to change a formula from the metric system to English units, and vice versa. Again, owing to improvements in apparatus and methods, some of the leading constants are being continually changed, thus necessitating changes in formulas in many instances to make the formulas agree with the new values assigned to the constants. For instance, it was only a few years ago that the mechanical equivalent of heat was stated to be 772 foot-pounds in all text-books; the value most generally used now is 778 foot-pounds, and it is probable that this value will be still higher ten years hence. In order to make formulas containing constants whose values have been changed slightly agree with the conditions of to-day, it is necessary to convert them, as it is termed, and it is the purpose of this article to show how this may be readily done.

It is worthy of remark that text-books on mathematics are strangely silent on this subject. There are a number of propositions in algebra that may be used for the conversion of formulas, but they are usually so hidden by their phraseology that they escape our notice when we desire to use them for this purpose.

In order to make the process more easily understood, we will give a few definitions:

A quantity is anything that can be measured.

A unit is that part of the quantity by which we measure the quantity. Thus 42 is a quantity and 1 is the unit by which we measure it; that is, 42 is really 42 1's. 42 foot-pounds is a quantity and 1 foot-pound is the unit; x, a and t are all quantities, but what their units of measure are we do not know until we have agreed to let them represent some particular collection of units.

A unit may be simple or compound.

A simple unit is one that involves only one particular kind of quantity, as: 1 foot, 1 degree, 1 pound, etc.

A compound unit is one that involves more than one kind of quantity, as: 1 foot-pound, 1 foot per second, 1 pound per square foot, 1 foot-pound per second, etc.

A constant quantity, or constant, is one that does not change its value after a value has once been assigned to it.

A variable quantity, or variable, is one that has its value constantly changed to meet changing conditions. Thus, in the formula, $v = 32.16t$, v and t are variables and 32.16 is a constant that is usually represented by g; that is, we usually write the formula $v = gt$. In this formula we may change the value of v or t as much as we please, but the value of g is not changed owing to a change in v and t. Constants are usually represented by the first letters of the alphabet, a, b, c, etc., and variables by the final letters, as p, t, x, y, etc.

The reciprocal of a quantity is 1 divided by the quantity; thus, the reciprocal of a is $\frac{1}{a}$; of $\frac{1}{3}$ is $\frac{1}{\frac{1}{3}}$ or 3; of $x + a$ is $\frac{1}{x + a}$; of $\frac{1}{2z + 1}$ is $2z + 1$, etc.

The first great difficulty that one strikes in converting formulas, is the converting of compound units. For instance, how can we change meter-kilograms to foot-pounds? This is easily done as follows:

Write the equation 1 meter-kilogram = a foot-pound; or letting m represent meter, K, kilogram, f, feet, and p, pound, $mK = afp$. In this equation, m, K, f, and p may be regarded as variables and a as a constant whose value we are to find.

It is a principle of arithmetic that if a quantity be both multiplied and divided by another quantity its value is not altered. For instance, multiplying and dividing 2 by some number, as 5, does not alter the value of 2; for $\frac{2 \times 5}{5} = 2$. This is the principle that we shall use to convert our formulas.

In the formula given,

$$m\,K = a\,f\,p.$$

We know that 1 meter contains 3.2808693 feet and that 1 kilogram weighs 2.2046223 pounds; hence, multiplying and dividing m and K by these constants, we have

$$\frac{[m \times 3.2808693] \times [K \times 2.2046223]}{3.2808693 \times 2.2046223} = a\,f\,p.$$

Now, calling the quantities enclosed by brackets $m_1$ and $K_1$, respectively, and dropping a, we have

$$m_1\,K_1 = 3.2808693 \times 2.2046223\,f\,p = 7.2330776\,f\,p.$$

That is, 1 meter-kilogram = 7.2330776 foot-pounds, say 7.233 foot-pounds. We will now work a number of problems that will illustrate the method in all its phases.

Problem I.—Change kilograms per square meter to pounds per square inch.

Solution.—The word per as here used always means division Hence, 1 kilogram per square meter may be expressed as $\frac{K}{m^2}$. But, when a quantity is to be divided by another quantity, the same result may be obtained by multiplying the dividend by the reciprocal of the divisor. For instance, $8 \div 2 = 4$; but the result 4 may be obtained by multiplying 8 by the reciprocal of 2, thus: $8 \times \frac{1}{2} = 4$. Hence, $\frac{K}{m^2}$ may be expressed $K \times \frac{1}{m^2}$ and since 1 m = 29.370432 in.

$$\frac{[K \times 2.2046223]}{2.2046223} \times \frac{39.370432^2}{[m^2 \times 39.370432^2]} = a\,p \times \frac{1}{1^2}$$

in which $1^2$ represents square inches.

Whence, dropping a, and using subscripts as before,

$$\frac{K_1}{m_1^2} = \frac{2.2046223}{39.370432} \times \frac{p}{1^2} = \frac{1}{703.0823} \times \frac{p}{1^2};$$

that is, 1 kilogram per square meter $= \frac{1}{703.0823}$ pound per square inch, or 1 pound per square inch = 703.0823 kilograms per square meter.

Problem 2.—The formula giving the total heat of steam above the freezing point is $H = 606.5 + .305t$, in which H is the number of thermal units and t is the temperature Centigrade. Convert the formula so that H will be measured in British thermal units and t in degrees Fahrenheit.

Solution.—One thermal unit $= \frac{9}{5}$ British thermal units, and $1°\text{C.} = \frac{9}{5} \times 1°\text{F.}$ But, since the temperature t is measured from the freezing point, or 0°C., 32° must be subtracted from the temperature Fahrenheit before substituting in the formula, or else the constant 606.5 must be altered. We will try both ways.

$$H = 606.5 + .305\,t;\ \frac{[H \times \frac{9}{5}]}{\frac{9}{5}} = 606.5 + .305\,\frac{[t \times \frac{9}{5}]}{\frac{9}{5}}$$

$$H_1 = 606.5 \times \tfrac{9}{5} + .305\,t_1 = 1091.7 + .305\,t_1.$$

In this formula 32° must be subtracted from the temperature before substituting for $t_1$, as the zero point on the Fahrenheit scale is 32° below the freezing point. Since this is somewhat inconvenient, we replace $t_1$ by $t_2 - 32$, and we have $H_1 = 1091.7 + .305\,(t_2 - 32) = 1091.7 + .305t_2 - 9.76 = 1081.94 + .305t_2$. Therefore, dropping the subscripts,

$$H = 1081.94 + .305\,t.$$

Problem 3.—Rankine's formula for the expansion of saturated steam is $pV^{\frac{17}{16}} = 475$, in which p is the pressure in pounds per square inch and V is the volume in cubic feet. Convert so that p will be in kilograms per square meter and V in cubic meters.

Solution.—Referring to Problem 1 and using but five significant figures, 1 cu. ft. $= \frac{1}{3.2809^3}$ cu. m., and

$$\frac{\left[p \times \frac{1}{2.2046} \times 39.37^2\right]}{\frac{1}{2.2046} \times 39.37^2} \times \frac{\left[V \times \frac{1}{3.2809^3}\right]^{\frac{17}{16}}}{\left(\frac{1}{3.2809^3}\right)^{\frac{17}{16}}} = 475;$$

$$\text{or } p_1\,V_1^{\frac{17}{16}} = \frac{39.37^2}{2.2046 \times 3.2809^{\frac{51}{16}}} \times 475 = 7.567\,5.$$

Dropping the subscripts,

$$p\,V^{\frac{17}{16}} = 7{,}567.5.$$

Note.—It was necessary to raise $\left(\frac{1}{3.28093}\right)^3$ to the power indicated by the exponent $\frac{17}{16}$, because $V^{\frac{17}{16}}$ had to be multiplied and divided by the same quantity, and this quantity had to be affected with the exponent $\frac{17}{16}$ since the variable V had to be changed to another variable $V_1$ having the same exponent. We knew the relation between V and $V_1$ (which was $V \times \left(\frac{1}{3.28093}\right)^3 = V_1$), and we reasoned that

$$\left[V \times \left(\frac{1}{3.28093}\right)^3\right]^{\frac{17}{16}} = V_1{}^{\frac{17}{16}} = V \times \left(\frac{1}{3.28093}\right)^{\frac{51}{16}}$$

Problem 4.—The formula for the velocity of escaping steam is

$$w = 4.43\sqrt{\frac{m\,p\,v}{m-1}\left[1-\left(\frac{p_1}{p}\right)^{\frac{m-1}{m}}\right]}$$

in which w is the velocity in meters per second, p and $p_1$ are pressures in kilograms per square meter, v is the specific volume, that is, the volume (in cubic meters) occupied by 1 kilogram of steam, and m is a constant. Convert so that w will be in feet per second, p and $p_1$ in pounds per square inch, and v the volume (in cubic feet) occupied by 1 pound of steam.

Solution.—We have, see Problem 1,

$$\frac{[w \times 3.2809]}{3.2809} = 4.43\sqrt{\frac{m}{m-1} \times \frac{\left[p \times \frac{1}{703.08}\right]}{\frac{1}{703.08}} \times \frac{\left[V \times 3.2809^3 \times \frac{1}{2.2046}\right]}{3.2809^3 \times \frac{1}{2.2046}}\left[1-\left(\frac{p_1}{p}\right)^{\frac{m-1}{m}}\right]}$$

It is not necessary to perform any operation on the fraction $\frac{p_1}{p}$, because the same operation will be performed upon both variables, and will cancel each other; that is, the result will be the same as multiplying both numerator and denominator of a fraction by the same quantity—the value of the fraction is not changed, and may be reduced to its original form.

From the foregoing we derive

$$w_1 = 3.2809 \times 4.43\sqrt{\frac{m\,p_1\,v_1}{m-1} \times \frac{703.08 \times 2.2046}{3.2809^3}\left[1-\left(\frac{p_1}{1}\right)^{\frac{m-1}{m}}\right]}$$

$$\text{Or, } w = 96.288\sqrt{\frac{m\,p\,v}{m-1}\left[1-\left(\frac{p_1}{p}\right)^{\frac{m-1}{m}}\right]}$$

(To be concluded.)

* * *

## EARLY COTTON SPINNING MACHINERY.

W. Midgley.

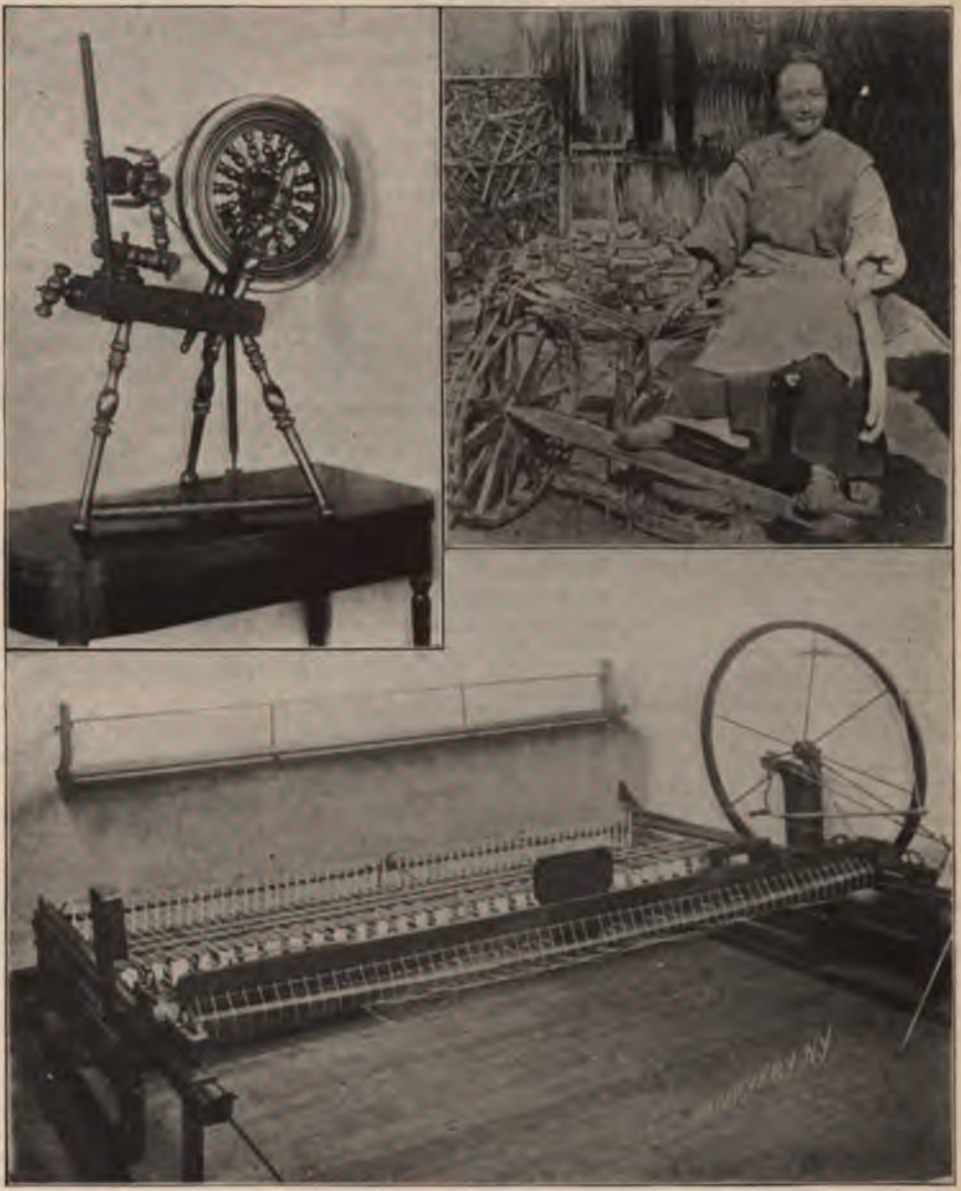
Amongst the varied collections at Chadwick Museum, Bolton Lane, England, there is none more interesting and appreciated than the unique collection of eighteenth century machinery. Here may be seen an old one-thread wheel and distaf, a hand card, the "Jenny," the power-card and "water-frame," together with a piece of old square wooden shafting taken from the mills of R. Arkwright at Cromford, Derbyshire. Here is also preserved the hand mule of Samuel Crompton, a native of the town.

In this age, when everybody's attention is directed to pressing forward in the race for wealth or economy of production, we propose, at the risk of being charged with the "fatalism of looking back," to trace the evolution of the cotton industry of the eighteenth century and lay before the readers of Machinery some account of the inventors and inventions of that period. From the middle to the end of the eighteenth century arose quite a number of independent and original inventions for the production of yarn, and the genius of that time laid the foundation of the prosperity of Lancashire. For centuries the only machine used for spinning cotton was the one-thread or Jersey wheel, which consisted of a large wheel driving a spindle, which twisted the yarn, whilst at the same time it was attenuated by the left hand. This was followed by the distaf, Fig. 1, which combined the spindle, flyer and bobbin for the first time. The bobbin was made to revolve quicker than the spindle, and wind on the yarn, by means of two grooved pulleys of different diameters. The flyer was employed for twisting the yarn and winding it regularly upon the bobbin.

A recent acquisition to the museum is a three-thread wheel, Fig. 2, still used in some districts in China. This machine marks a period between the one-thread wheel and the "Jenny," and is of very rude construction. It consists of a wheel turned by the feet, which gives motion to three spindles by means of a piece of hide passing around them. When the yarn has been drawn out and twisted, it is wound on the spindle in the shape of a cop by means of the stick in the right hand. The operations of spinning and weaving were usually carried on in the same house, the daughters spinning the yarn for their father's loom. The shuttle of the loom had to be thrown through the warp by hand; and with broad looms, two men were required, one on either side of the loom, to throw it across. This was a very slow and costly process, and in 1738 John Kay invented a new method of throwing the shuttle which more than doubled the production of the loom. He lengthened the slay, or board along which the shuttle runs, and by attaching strings to pickers at opposite ends of the slay, and held by a peg in the weaver's right hand he, by a sharp pull of the string, threw the shuttle across the loom. Weavers had now to waste their time in collecting yarn from their neighbors, who fixed their own price and deprived them of their profits.

To bring the supply of yarn into harmony with the demands of weavers, some improvements in spinning had to be made, to increase the production. As early as 1738 we find a patent for "spinning by rollers" taken out by Paul & Wyatt, of Birmingham. A mill was built at Northampton, containing 250 spindles, which was driven by water, but it proved a failure and the venture was abandoned in 1743. Paul took out a second patent in 1758, but it was not until the introduction of the "Jenny" in 1774 that any great advance was made. James Hargreaves, its inventor, was a weaver of Standhill, near Blackburn, and in humble circumstances. The Jenny was intended to spin roving into yarn, and he is said to have received his inspiration through seeing a distaf overturned when the spindle revolved in an upright position. From this he reasoned that if a number of spindles were placed side by side in an upright position, several threads might be spun at once. He contrived a frame, in one part of which eight rovings A were placed, and in another, eight upright spindles B. The rovings were first passed between two bars of wood C D, which could be clasped so as to hold the threads. These bars formed a traveling carriage E, moving to and from the spindles, a distance of about sixty inches. The carriage was drawn out by the spinner's left hand, while with the right he put in twist by means of a hand-wheel G, driving the tin cylinder H. The latter communicated its motion to the spindles by means of cords passing round wharves on the spindles. When the carriage had traveled about three-quarters out, the clasp was closed, thus preventing the further passage of roving; and the threads were attenuated by slowly drawing out the carriage, the thick places being drawn out by the twist first running into the thinner parts and causing them to resist drawing. This made the yarn more uniform in thickness, and the same method is still employed for attenuating waste yarn on the "billey." The carriage was then returned and by letting down the presser wire K, the yarn was wound on the spindle in the form of a cop. With this imperfect machine Hargreaves spun weft for his own looms, but, the secret leaking out, a mob broke into his house and forced him to leave the country. He then erected a small spinning mill at Nottingham, and in 1770 obtained a patent for his jenny, and began to build "Jennies" for sale. Their productiveness being manifest, they were brought into general use. In 1779—a period of distress—a mob destroyed all "Jennies" and "Waterframes" in the Blackburn district, sparing those "Jennies," however, with less than twenty spindles, as these were admitted to be useful. His patent rights were also contested by the Lancashire manufacturers, and he was deprived of their benefit. Although this prevented him from receiving the legitimate reward of his invention, he continued his spinning concern until his death in 1778, when his widow received £400 for her husband's share in the business, thus proving that he must have spent his last days in comfort.

Hargreaves rapidly improved his machine after taking out the patent. In the first place the toe was dispensed with for working the faller, which was now worked by the left hand. A cord was fixed to a curved portion of the presser M, and passing round three pulleys on one end of the carriage was attached to the outer end of the framing. The center pulley N, slid in a groove and was attached to a latch near the clasps. As the carriage was moving in, the spinner pulled the latch, causing the sliding pulley N to recede from the other two and depressed the faller to the desired level for winding the yarn upon the spindles. Hargreaves also rapidly increased the number of spindles from eight to thirty, sixty and in some machines to 120. In these large machines it was difficult to keep the carriage square and draw all ends alike. To remedy this defect, he attached a band to the framing near the spindles, and passing it round two pulleys, underneath and at opposite ends of the carriage, afterwards fixed it to the outer end of the framing. A similar band was conducted in the opposite direction, and, the same tension existing throughout the length of the bands, the carriage moved out perfectly parallel to the spindles. One of the chief faults about the earliest machines was that the slubbing box being fixed near the spindles, a considerable amount of slubbing hung down when the carriage moved in and was very liable to catch dirt from the floor and also to become entangled and break. He therefore caused the slubbing box to slide to and fro with the carriage, as in the sketch, which considerably reduced the risk of dirty and broken slubbings.



EARLY SPINNING MACHINERY.

Fig. 1. Distaf, combining Spindle, Flyer and Bobbin. Fig. 2. Chinese "Three-thread" Wheel. Fig. 3. Hargreave's Spinning "Jenny."

The above description and photograph are taken from the old jenny in the Bolton Museum, which is probably the only one remaining in England. It had been in constant use for nearly a century, spinning woolen weft for hand-looms in a hill-side house near Slaithewaite, where it was discovered and purchased for the Corporation.

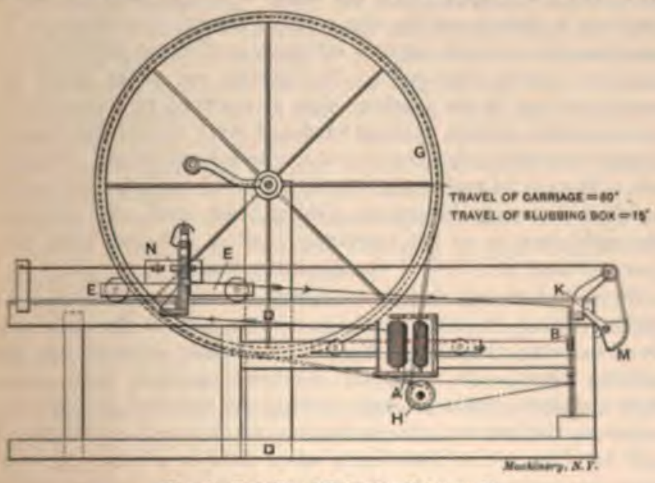
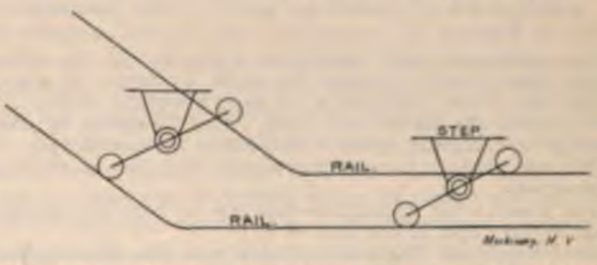


Fig. 4. Details of Spinning "Jenny."

## TRAVELING STAIRWAY.

Among the transportation exhibits at the Paris exhibition is a traveling stairway built by the Otis Elevator Company. The general scheme comprises a system of parallel rods connected together and driven by a chain, which carry the triangular supports for the stair treads, as shown in the sketch. The treads are maintained in a horizontal position by two rolls which are connected by short bars to the triangular support, as indicated. These rolls run, one on each of two parallel rails, which are further apart on the incline than on the level. Thus the treads, which form a smooth moving platform at the foot of the incline, are kept horizontal when they commence to ascend, and there is no tendency to tilt either backward or forward. It is said in the "Sibley Journal of Engineering," from which this information is taken, that this particular stairway is capable of handling, with an expenditure at the motor of from 30 to 35 horse-power, 7,200 people an hour, the height of the lift being 20 feet, 2½ inches and the speed 90 feet per minute.



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## MAY, 1900.

The regular edition of MACHINERY for May is 21,500 copies.

MACHINERY has the largest paid-in-advance circulation of any mechanical paper in the world. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. Except on special quarterly numbers, no papers are sent free other than to advertisers, exchanges and circulation agents. AMERICAN MACHINERY is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition.

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## SOME CIRCULATION FIGURES.

The "American Machinist" has been at last persuaded to give out a circulation statement—of one issue—from which we venture to quote:

On March 26th we counted our list, and it stands as follows:

| | |
|---|---|
| Paid subscribers | 5,399 |
| Advertisers, exchanges and complimentary | 812 |
| Sent to London for European edition | 3,000 |
| News Company's order | 6,550 |
| Total | 15,761 |

The number of paid subscribers accredited to the office is smaller than formerly because the entire European list, once included here, is now included in the 3,000 European edition.

No copies are taken back from News Company as unsold. None go free, regular, to any one without an equivalent.

This may vary next week up or down—if it does we shall print more or less.

This is not a big circulation—but it's the best circulation enjoyed by any paper in our line.

It's a circulation that reaches more men who are responsible for results in shops making all kinds of machinery than all other papers combined.

For purposes of comparison we some time ago estimated the circulation of the "American Machinist" at 12,000 copies, to which add 3,000 foreign papers first printed on March 26, 812 advertisers, exchanges and complimentary, and the total obtained, 15,812, we may fairly claim justifies our estimate.

If the 3,000 copies sent abroad were sufficient to cover the entire European list as well as to place the paper "on sale on the book-stalls in all the manufacturing cities of the continent," how many is the actual paid foreign circulation? How is the statement that the paper is placed on sale, etc., which is quoted from a booklet recently issued by the "American Machinist," and the fact that 812 copies are sent to "advertisers, exchanges and complimentary," reconciled with the assertion that no copies are taken back as unsold and that none go free to any one without an equivalent?

The character of circulation always interests advertisers, and we wish our contemporary had given some facts to justify its claim to have the best. Here are some figures taken at random from our 1899 reports giving a summary of the mechanical readers from a few representative works in different parts of the country. These shops have not been chosen because MACHINERY makes a better showing therein than in others; on the contrary, being old and long established concerns they have been, within a few years, the strongholds of our competitor; and the percentage of MACHINERY readers in some of them is much smaller than in many other shops. We could readily have selected the same number of shops in which every employee, from the head of the concern down, is a subscriber to MACHINERY:

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total subscript'ns in each shop. | | | | | | | | | | | |
| To MACHINERY | 60 | 51 | 52 | 72 | 296 | 10 | 110 | 130 | 60 | 33 | 145 |
| To other Mechanical papers | 10 | 20 | 15 | 21 | 123 | 0 | 31 | 40 | 10 | 20 | .. |
| Supts. and Ass't. Supts. | 2 | .. | 2 | 2 | 2 | .. | 3 | 2 | 2 | .. | 3 |
| Subscribers to MACHINERY | 2 | .. | 2 | 2 | 2 | .. | 1 | 1 | 1 | .. | 2 |
| Draftsmen employed | 5 | 12 | 2 | 5 | 36 | 1 | 25 | 30 | 2 | 4 | 36 |
| Subscribers to MACHINERY | 4 | 2 | 2 | 4 | 21 | 1 | 5 | 8 | 1 | 3 | 22 |
| Foremen and contractors | 9 | 21 | 7 | .. | 37 | 1 | 37 | 19 | 10 | .. | 19 |
| Subscribers to MACHINERY | 6 | 8 | 4 | 8 | 24 | 1 | 8 | 18 | 8 | 6 | 15 |

So many components now enter into the circulation figures of the "American Machinist"—the "complimentary list, the foreign edition, which is placed on sale on the book stalls, the extra calls, back subscriptions, etc.," that we confess our inability to estimate its circulation; but if our contemporary is really willing to have the actual figures known, let us suggest a plain statement, giving simply the figures for every issue of the preceding year—like this:

*The regular editions of* MACHINERY *for the last twelve months are given below:*

| 1899. | | 1899. | | 1900. | |
|---|---|---|---|---|---|
| June | 17,750 | November | 17,750 | March | 25,000 |
| July | 16,650 | December | 18,500 | April | 21,500 |
| August | 17,150 | 1900. | | May | 21,500 |
| September | 18,000 | January | 20,000 | | |
| October | 17,500 | February | 20,500 | | |

L.

* * *

## DIAMOND TOOLS IN THE MACHINE SHOP.

While most machinists are quite familiar with the general properties of the diamond and particularly with its extreme hardness, there are, apparently, not many who appreciate its advantages as a cutting tool for many of the regular operations in the machine shop, which are now inferiorly performed with ordinary steel or mushet steel tools. The general use of the black diamond or bort in the machine shop is confined to truing emery or corundum wheels, turning hardened steel, chilled cast iron or similar refractory substances and working hard rubber, celluloid, etc. The use of such tools, correctly shaped for lathe and planer work, for turning, boring or planing brass, steel, cast iron and wrought iron, is as yet extremely limited, although they have been so used in a limited way for many years.

It is well known that the accuracy of many machine tools is quite seriously impaired by the inevitable wear of the tools used for removing the metal. Since the amount of wear on any cutting edge is an extremely indefinite quantity, it is always difficult to determine beforehand what the variation will be from exact parallelism in a piece being turned or bored, or whether it will be plane within close limits when faced in a lathe. If, however, the cutting edge be of a substance that can be used for an indefinite period without showing perceptible wear, even when examined under the microscope, it is evident that one of the chief factors in producing inaccurate work will be eliminated. As the only substance known that will fulfil these conditions is the diamond, a statement of its limitations and practicable application will be of interest.

The diamond is the hardest of all substances, being rated as 10 in the scale of hardness. The next hardest stone is the ruby, which is rated at 9; but the difference in the hardness of these stones is nevertheless so great that they are comparatively about as hardened steel is to tin. The diamond which is most used and is best adapted to mechanical purposes is the black diamond or bort, which is found only in South America and there only in the provinces of Bahia. On account of the extended use of the black diamond in the industrial arts, the price has been raised by the syndicate controlling the production so that now the retail price is about $38 per karat or somewhat more than the price for the small white diamonds. Although the white diamond is harder than the black variety, it is not as well adapted to mechanical purposes as it has well defined lines of cleavage and will readily split along these lines when subjected to peculiar stress. The black diamond is amorphous in its structure, and is, therefore, more stable as a cutting tool, although somewhat softer.

The proper setting of a black diamond is an art, and shaping and sharpening the cutting edges is said to be a trade secret, since the process used for grinding the white diamond is not successful on the amorphous variety. This fact, together, with the high first cost has naturally restricted the use of such tools to special operations in most cases. It was, therefore, with considerable surprise that in a visit to a shop devoted to the manufacture of certain specialties we saw the commercial use of diamond tools as finishing tools on lathes, boring mills and other machines. On account of the shop policy we cannot, as yet, give much specific information on the subject beyond a brief summary of the possibilities with these tools.

The apparatus made in this shop is of such a nature that it must be extremely accurate in its working and it must also sell at a reasonable price. The materials used in construction include hard rubber, which has to be machined. To those unfamiliar with the properties of this apparently easily-worked substance, it will probably be new that it is one of the most difficult materials to handle with steel tools. In fact, it is impossible to do accurate work on it with anything of less hardness than the diamond. It was thus that in this particular instance an excellent opportunity was given the superintendent to use diamond tools on the different metals, and he has done considerable experimenting in a quiet way with most remarkable results. Articles made of brass are first roughly bored, turned or faced with ordinary steel tools and then the finishing size is obtained, in many machines, with a diamond properly set and shaped. The surfaces produced are wonderfully smooth and accurate, a most difficult condition to obtain in brass, especially with some grades. Cast iron cylinders, perhaps ten inches in diameter and twenty-four inches long, are bored with a variation of from only one-quarter to one-half thousandth of an inch from parallelism. Of course, such results can be obtained with ordinary tools, but only at the cost of great care and attention and with always an uncertainty of how many trials will be necessary to accomplish such refined conditions. With the diamond tools, however, and especially in boring cylinders, this uncertainty does not exist. A cut can be started through a cylinder with the certainty that as far as the tool is concerned the original size will be maintained throughout. In the case of turret tools, the great freedom from error on account of the non-wearing of the tools saves much labor on the part of the tool-maker and enables exact duplication for months with scarcely any attention. To offset these merits are the disadvantages of high first cost, liability to breakage or loss and difficulty in obtaining correct shapes, whether special or ordinary.

Notwithstanding these difficulties, from what the writer saw and was told, it appears evident that diamond tools are destined to play an important part in machine shop operations in the future; but at present the trade appears to be poorly supplied, as there are but few dealers who appreciate the conditions to be met or who will take the pains to ascertain what they are.

* * *

A freak shown by a contemporary is a ball-bearing rifle, which has the remarkably valuable feature of a series of balls in the rifle grooves to reduce the friction of the shot in the bore of the gun.

## DESIGNING JIGS AND FIXTURES.

EDWIN C. THURSTON.

One of the problems not easily solved in designing jigs and fixtures is the amount of time that should be spent on a tool. Designing and building are first costs and of more importance than the later expense of repairing tools, which, if well built, need not be much.

If a tool is to be used in the continuous production of pieces, I should take time to consider all conditions. If the tool should be a jig that required turning over in order to remove the work, or to drill holes in different planes, it should be as light as possible, but not so light as to spring in clamping the work, or by the drill pressure. This latter may be overcome by ribbing in places of the greatest strain. I have seen jigs for holding quite large pieces so constructed that they could be turned over with comparative ease, brought against stops located under several drill spindles, carrying drills, bits, counterbores, etc., instead of resetting and changing the tools for each hole. If the drilling operations are all in one plane the jig should be heavier. For milling I should make the fixtures heavier than seems necessary to hold the piece under the cut, so that it will not vibrate or spring. I remember one fixture in particular for holding a fair-sized, irregular-shaped piece that was milled on two faces at one time. The fixture was designed to be quite a little heavier, we thought, than necessary, but it proved none too heavy on trial. Another for the same piece, designed to be strong enough, was not sufficiently rigid to stand up under the cut. A little time spent in designing a tool to look neat and in proportion is not a useless expense.

Why does it take so much time to design a simple tool, is often asked. In the first place, the designer may have a drawing or sketch of the piece operated upon, or perhaps a sample piece; he is told that such holes are to be drilled, such surfaces milled; the drilling is to be done on a certain drill press and the milling on a certain milling machine, or he may choose his machine. The tool must be designed so that it can be used conveniently on the machine, be sufficiently rigid to stand up under the cut without springing, arranged so that the piece operated upon can be securely held and quickly put in place and taken out, surfaces provided for wear, clearance for dirt, burrs, etc. The necessary drawings must be made, giving dimensions and details; there must be work done by the pattern maker, foundryman and tool maker. After all this is done you will find that time has not been waiting.

I have seen tools designed in haste that have come to far from filling the purpose for which they were intended that they either had to be re-designed or discarded. After such a tool is made and even if it has had a fair amount of time spent upon it, one feels greatly disappointed to see where it could be improved, and especially so when others mention how this or that would have been handier or better, and ask why you did not fix it that way.

If a tool must be designed on short notice and the cost figure is set low, give it to a good designer, for with his experience he will probably lay it out the first time so that it will do the work satisfactorily and cost less to build, than if designed by a less experienced and lower-priced man.

In designing, be careful to notice the following: Do not think that after you have your layout complete there is no chance for improvement; before putting on dimensions and detailing, submit it to the foreman who expects to use the tool as well as later to the pattern and tool makers. They may make a suggestion that will be a key to a scheme that you have had in mind but could not get in working shape, so to speak, or they may give you some direct points where the tool could be improved or more easily built. This may mean a new lay-out, but it will be found time well spent and in the end an efficient tool.

Many jigs and fixtures are drawn assembled, with all the dimensions for pattern work as well as for the toolmaker; also sizes of stock screws, washers, etc,. covering the drawing with dimension lines and figures to such an extent that it is almost impossible for the workman to pick out the parts, making the chances for mistakes greater than if the small pieces were detailed and only the figures for the toolmaker given for one or two large pieces on the assembled views. If the pattern figures are desired, take a piece of tracing paper and copy the pieces separately, giving the necessary figures on these tracings; this will be welcomed by the pattern maker, and the drawing with small parts detailed and only the necessary figures given, will be welcomed by the tool maker, saving more than enough time in building to pay for the extra time spent by the detail man in making the drawings as described.

Do not put bushings, guiding surfaces or supports in a movable piece, such as in a hinge cover or clamps, for there is danger of the bushing or guiding surface not coming to the same place every time. If it is necessary to do so, be sure to have liberal bearings and good fastenings.

Use as few springs as possible, for they are unreliable. I have seen considerable work thrown away just because a spring failed to hold the piece in place; it was either too weak at the start or had been a little too stiff and not sufficiently tempered to keep it from bending under the pressure, thus allowing the piece to get out of place and be spoiled.

Avoid trying to do too much with one tool; for instance, if you design a jig for drilling holes in three or four sides of a small piece and after it is built it is found necessary to change the location of a bushing or bearing, the chances are that the tool maker will have a hard time to make the change and still keep the relations correct, especially where the guiding holes are in the bearings and are in one piece that must be annealed to make the change. If it is necessary to drill several holes as stated, it is better to use separate pieces for the guiding holes, bushings and bearings as far as possible, making a tool that is easier to build; for the tool maker can get the separate pieces made, and set and dowel each one independently of the others. A better way still is to make two tools instead of trying to do so much with one.

Notice that necessary recesses for burrs and dirt are always provided. Cut a groove at the joining of two bearing surfaces in jig or fixture when the piece operated upon has a similar edge; there is almost always a burr on the edge, or dirt is apt to stick in the corner unnoticed, to be discovered after considerable work has been spoiled.

Take the sharp edges off the tools so that a man can handle them without cutting his hands, and if there are handles for clamping, etc., make them such a size and form that it will not be necessary for the workman to have his fingers tied up in rags.

Consider the help you can give the tool maker in providing two or more surfaces that can be planed and used as working surfaces; one of these will answer as a place for marking the operation for which the tool is to be used; also provide lugs or posts for supporting a piece or for locating a center. These can be chipped off after the tool is finished.

If a tool is to be used for a continuous production of pieces, the bearing surfaces should be hardened; and for jigs use hardened steel feet.

Do not make the guiding surfaces for drills too long in the bushing, and if a bushing is inverted, which is done quite often in folding jigs, a piece of hardened sheet steel with a hole a little larger than the drilling tools used should be fastened over the bushings to prevent the destruction of the bearing surface around the bushing. When the drilling tools are small compared to the jig, stops should be provided, as the small drills or bits will not be stiff enough to bring the jig under the spindle, giving as a result a hole on an angle.

On small interchangeable work, the following relations will be found quite satisfactory, when a hole is made with a starting drill, following drill and bit. A starting drill for a hole under 5/16 in. diameter should be .001 in. smaller in diameter than the following drill, or .002 in. smaller if the hole is to be over 5/16 in. diameter. The starting drill should have a shank ground to the same diameter as the bit that finishes the hole; both are to be guided by the bushing, while the drill follows the hole made by the starting drill and does not touch the bushing.

If you are drilling a hole in cast iron, say .250—.251 in. diameter, where the limit is .001 in., have the starting drill .241 in. diameter for cut, following drill .242 in. diameter and the bit .250 in. diameter. If the hole must be within .002 in. limit, that is .250—.252 in. diameter, the same size starting and following drills can be used as before, but the bit should be .251 in. diameter.

In wrought iron and steel, for a hole with .001 in, limit, the bit should be .0005 in. above lower limit of hole and .001 in. above lower limit when the hole is to be within .002 in. limit. For instance, the hole .250—.251 in. diameter should have the starting drill .243 in. diameter of cut, following drill .244 in. diameter and the bit .2505 in. diameter; a little less stock is removed by the bit than in cast iron. Now if the hole is to be .250—.252 in. diameter, the bit should be .251 in. diameter, the starting and following drills remaining the same as for the .250—.251 in. hole.

The hole in bushings for guiding tools for holes over .100 in. diameter, should be .001 in. diameter larger than the bit used, for smaller holes if you wish close work, the diameter of the guiding hole should be .0005 in. diameter larger than the bit.

Make bushings of tool steel, hardened and lapped for guiding drills and bits rather than trying to guide them in holes in the supports or body of the tool; a new bushing could be put in place cheaper than to anneal, bore, brush and reharden a solid piece in which a hole had worn large. Where a large number of bushings are used it might be well to keep some sizes in stock; a little variation could be made in the design of the tool to suit the stock size bushings.

* * *

## SHOP KINKS.

**A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.**

**Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.**

### SIMPLE DISTANCE GAGE.

W. G. R. says that a simple yet very convenient distance gage may easily be made like that shown in Fig. 1. The materials necessary are two steel rods and a piece of spring-tempered sheet steel. A convenient size for the rods is ¼" in diameter and for the spring about 4" by 1", No. 20 gage. An elongated hole a little longer than that needed to take in the two rods side by side is made near each end of the spring. The ends of the spring being brought near together, the rods are thrust through the openings and securely held in any desired relative position by the tendency of the spring to straighten out. Different lengths of rods may be provided for varying the capacity of the tool.

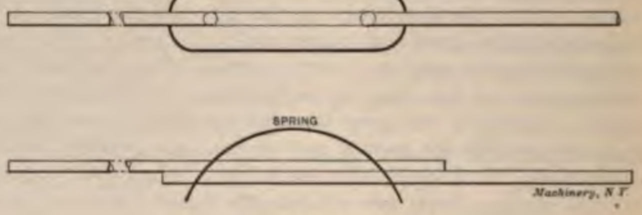


Fig. 1.

### TO SET A TAIL-STOCK—DRILL HOLDER—BORING TOOL HOLDER.

M. Long, Geneva, N. Y., says: I have seen a number of ways given for setting the tail-block so that the work will turn straight, some quite elaborate, involving the turning up of a piece, but I never saw any quite as sure and simple as the way I do. Take any piece of centered stock or mandrel (preferably about the length of the work to be turned, in order to avoid moving the tail-block) and put it on the centers. Put a tool in the

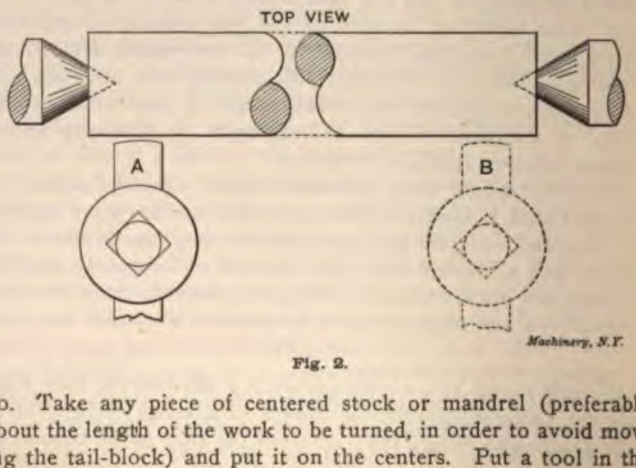


Fig. 2.

vith the blunt end toward the bar. Revolve the bar with 1 and move the tool up until it just touches, as at position 2. Then remove the bar from the centers, move the to position B, at which position the tool should touch at the same place, when turned end for end and re- on the centers, as it did in position A. Adjust the tail- ntil the tool touches the bar the same at both ends. o matter how inaccurately the head and tail-block may he shears, your work will come out parallel (allowing for wear of tool). In this setting care must be taken live center is true.

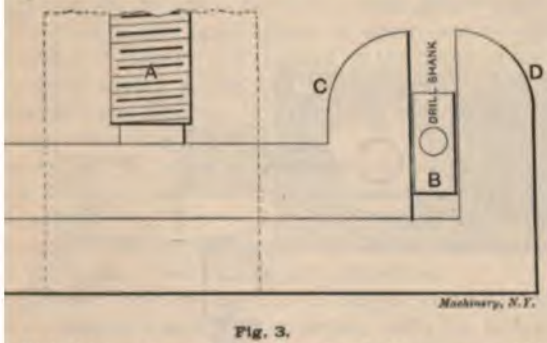


Fig. 3.

lrill-holder, shown in Fig. 3, is, I think, a much better for holding a flat drill for lathe drilling than the ordi- older. Two pieces of half-inch square iron are bent up n in cut. The drill is placed in position for work, the and finger being placed at C and D. Draw the pieces the drill and tighten the tool-post screw A on them, and justing is all done. The tool-block does not have to be 1 up or down, as with the old method, which is handy, ly when other tools are being used. In withdrawing the clean out chips, it does not have to be brought back clear the holder, but just out of the work and lifted up. I pre- flat drill to the twist for most lathe drilling.

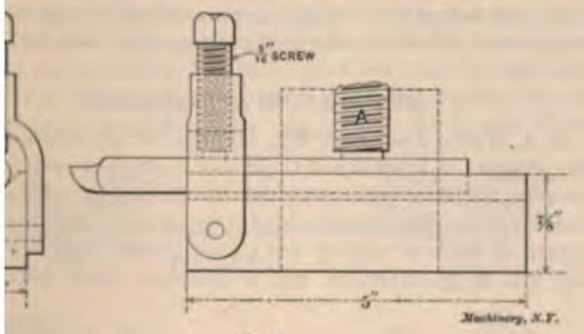


Fig. 4.

e lately seen some small boring-tool holders illustrated, nink none of them are quite as handy as one I have, as in Fig. 4. (I am not the originator of this tool.) The ar is firmly held as close as possible to the working end the whole held by tool-post screw A. It will hold round, or octagon steel from 1/8" up to 1/2" diameter. It is also or special tools when turning.

### TO MAKE COIL SPRINGS IN A VISE.

es W. Dilkes, Plainfield, N. J., says that the following of making coil springs is handy when a special spring is in a hurry and the time cannot be taken to rig up a lathe purpose. A closed or open spring can be made any desired pitch with a little practice, as shown in Fig. 5. A A represents the jaws of an ordinary machinist's vise, B B two blocks of hard wood, C a plain round steel rod of a size to make the spring required, and D a lathe dog to hold the wire to the mandrel and to serve as a handle. In Fig. 6 an end view of the blocks is shown in which E E are the V-grooves for the mandrel and wire. This device is used in some shops, but is quite unknown in many others.

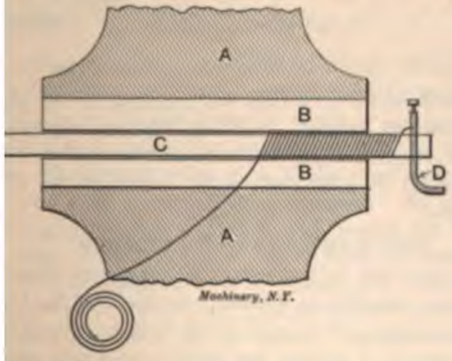


Fig. 5.

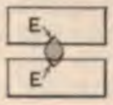
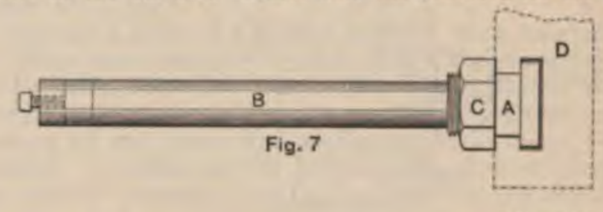


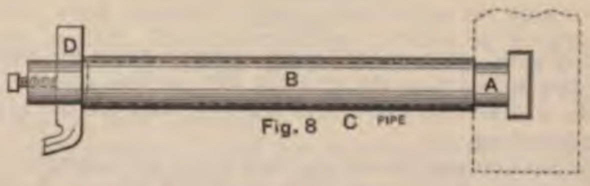
Fig. 6.

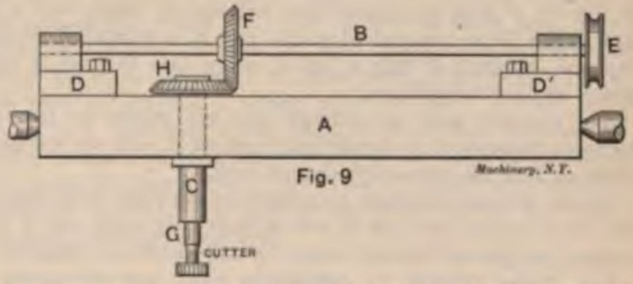
### TWO EXTENSION CUTTER BARS—MILLING RIG FOR THE LATHE.

"R. S.," Fond du Lac, Wis., says that the three following kinks have helped him a great deal in his shop practice.

Figs. 7 and 8 are two forms of extension tool-posts for the shaper. The one shown in Fig. 7 is a straight bar with a shoulder turned at A to fit the tool apron and threaded for the nut C which clamps the post in position. "R. S." says that he has used an extension with success, 14" long and 1" in diameter. In this bar a 1/4" square hole was provided for the tool.







The extension shown in Fig. 8 is made with a shoulder at A, but instead of being clamped with a nut to the apron, a pipe C is slipped over B, which thus supports the tool D, since the tool slot in B extends within the length of the pipe, as indicated by the dotted line.

The device shown in Fig. 9 is a milling rig for the lathe which has been used to cut a T-slot in a tube when it could not be done on a planer. The bar A is held in the centers of the lathe and the tube to have the T-slot cut is clamped to the carriage and fed along by the lead screw. The power is taken from an independent source through the sheave E which transmits it through the shaft B and bevel gears F and H to the cutter G. The bar A forms a bearing for the spindle C, as shown by the dotted lines.

### ADJUSTABLE REAMER—SETTING MILLING CUTTERS.

"D. C. K.," Cincinnati, Ohio, says: Fig. 10 is a sketch of an adjustable reamer, description of which is hardly necessary, as the sketch shows the construction quite clearly. Fig. 11 is a handy kink for a milling machine hand to remember in center-

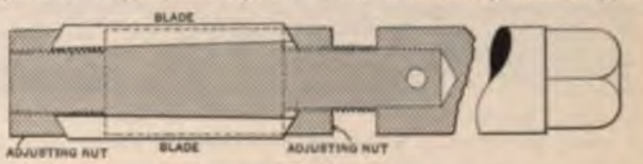


Fig.10

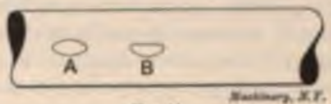


Fig.11

ing keyway cutters and the like. When the cutter is central it makes a mark somewhat like A on the shaft, and when off center as at B. With a little practice it becomes an easy matter to center a cutter, and it will be found to be a shorter and better way than by using a square and scale.

### TAPER INDICATOR FOR THE LATHE.

R. B. Casey, Lancaster, N. Y., says: I enclose sketches and description of a tool which will be of great assistance in setting the tail-stock of lathe to proper distance for turning tapers, and while it may not be of much use to the expert, it will appeal to a large class of workmen who have experienced trouble in that line of work, and have (as has the writer) watched the finishing cut fast approaching the shoulder with feelings akin to those of the man with his foot caught in a frog, while the fast express is approaching.

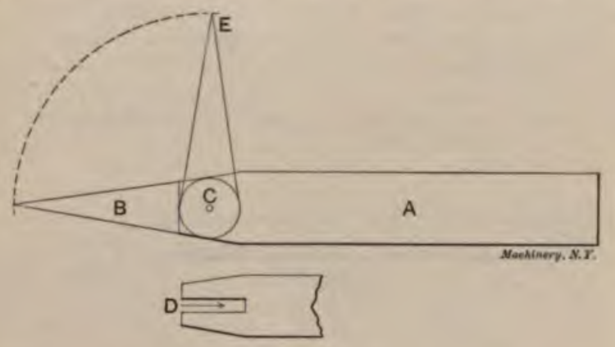


Fig. 12.

To make the tool, take a piece of flat iron any convenient size, to fit in the tool-post of the lathe, which will serve for the shank A Fig 12; 1" x ½" is a good size, and will fit almost any lathe. Saw a slot D in one end of shank, and fit a pointer B of steel in same, securing it with a pin C, using care to have it work easily, without being loose.

Saw the slot back far enough into the shank, so that the pointer when moved to the upright position E, will not fall down while moving the carriage back and forth.

To use the tool, measure accurately on the piece to be tapered the exact length, then cut to size at large and small end; a cutting-off tool should be used when the taper ends at a shoulder.

Use thread calipers in getting the sizes, and be careful to caliper at the exact distance. Place tool in tool-post, and move the tail-stock over till the pointer touches at both points that have been turned to size, then proceed to cut the taper. If care be used in measuring and calipering, the taper will be correct.

### CENTERING DEVICE-TURRET LATHE TOOL.

Frank Greiner, New York City, says that Fig. 13 comes in handy when there are a lot of round pieces to be centered, to be turned down afterward. A is the body, made of machine steel. B is made of tool steel and hardened. It is forced away from the body by means of the coiled spring D and is prevented from slipping off by the collar C. The angle in front is about 60° and the pressure of the spring brings the work to the center. The device may either be worked with an ordinary twist drill, or a combination drill and center reamer.

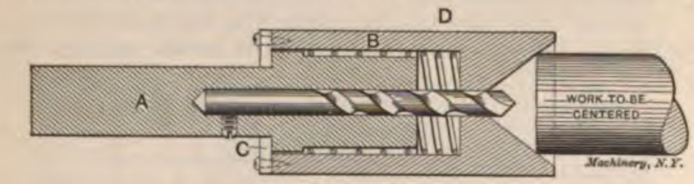


Fig. 13.

Fig. 14 is a pin pointing rig, which has given very good results and which can be used on any screw machine. A shows the body of the pointing chuck, which carries the round cutter B. The bushing C is interchangeable with others for different sized pins. Cutter B rests in a chamber, bored at right angles to the chuck. It need not be any thicker than ⅛" and can be ground to point any shape. To insure a smooth cut high speed is essential. D is the body of the clamping jig with the hardened jaws E E. The pivoted part F is kept away from D by the spring G, which will release the pin after pointing as soon as F is drawn off the hardened roller H. If short pins are to be pointed another roller may be placed alongside of H in order to hold the pins, until withdrawn from the bushing C. The opening between the jaws is regulated by the screw K in D. The thread on O should be fine, to permit close adjustment of roller H. N is the turret head of screw machine and M is the cross-slide.

The operator holds the turret bed lever with his right hand and feeds with his left. In normal position the clamping jig is pushed away from the chuck just enough to allow the operator to place a pin in bushing C. Then the clamp jig is moved in towards the work. The higher the jig climbs on H, the tighter the jaws grip the work, so that when the cut is at its completion and the tendency of the work to slip in the jaws is greatest, the grip of the jaws is tightest.

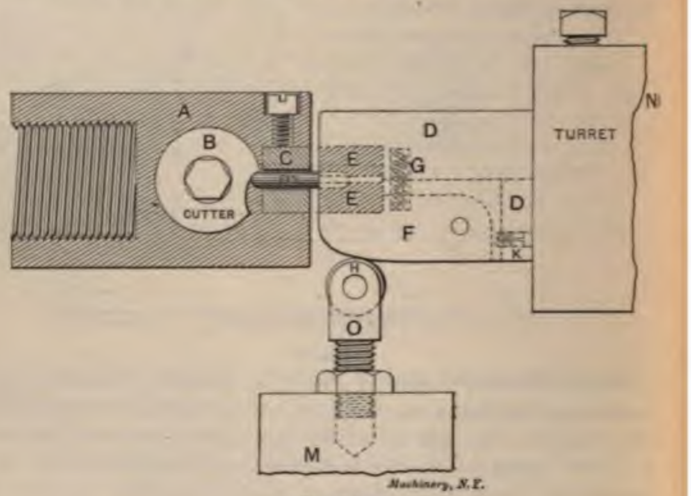


Fig. 14.

As said before, the rig has given satisfaction, and with a live boy behind it, it will easily turn out 5,000 pins (one end pointed) in a day.

### KEY-SEATING ATTACHMENT.

B. J. Willey, Louisville, Ky., says that he recently had a number of gears to keyseat and there was no keyway cutter available or even the usual goose-neck tool for the shaper. He made the tool shown in Fig. 15 and found it to be very satisfactory. The length of the tool need be but a little greater than the width of the hub to be keyseated, and is therefore much stiffer than a forged tool held in the tool-post and projecting out beyond the tool-post screw far enough to cut a keyway of equal length. The cutter A is square and made of self-hardening steel. The flattened shoulder B gives means for screwing the shank into the tool apron.

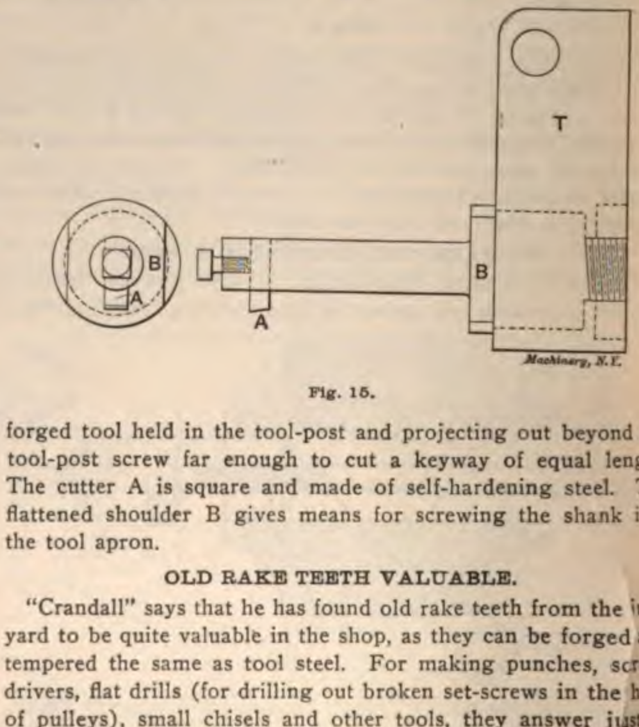


Fig. 15.

### OLD RAKE TEETH VALUABLE.

"Crandall" says that he has found old rake teeth from the junk yard to be quite valuable in the shop, as they can be forged and tempered the same as tool steel. For making punches, screwdrivers, flat drills (for drilling out broken set-screws in the hubs of pulleys), small chisels and other tools, they answer just as well as commercial steel. Old files are also good for making tools if the cuts are well ground out before forging.

# LETTERS UPON PRACTICAL SUBJECTS.

## HARDENING HAMMERS.

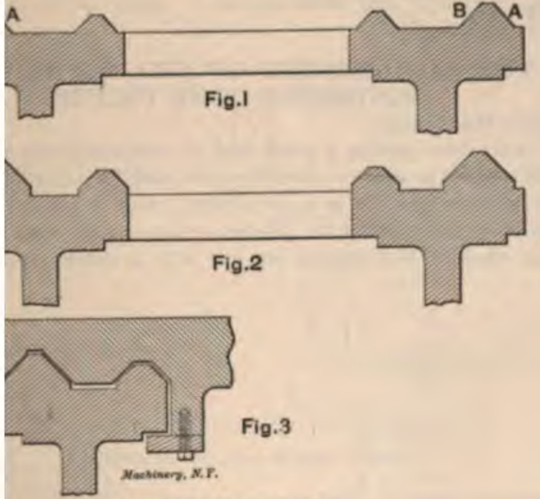
CHINERY:
noticed your description of how to harden a hammer,
nswer to J. A. C., in April issue.
say, a hammer should not be hard at the eye if it is to
My method of tempering a hammer is to heat it on an
llowing the rod and all to get hot together. When at
heat dip the ball in the water to the proper depth, and
e time have a small stream of water, say one-quarter
ter from hose or tank, poured on the center of the face.
perly cooled, polish ball and face quickly and allow
f the eye and rod to draw both ends to the proper
n it should be dipped.
method the center of face can be made extremely hard,
battering, while at the same time the outside can be
vely soft and not liable to chip or spall off. The ball
rdest at the extreme point, where it is most used. The
he hammer will be soft as it should be.
ammer faces are dipped the outside corner or rim is
t, making it very hard or brittle, while the center may
t, and batter.
sed this method for years and can recommend it as be-
ass.

HUGH HILL.

* * *

## LATHE SHEARS.

CHINERY:
e lathe is the most important of all machine tools is
by the great amount of thought and study given to
ners and mechanics. It is the aim of the designer to
a perfect machine, at the same time to try to provide
keeping all parts in perfect alignment, and, if pos-
vercome the evil effects of wear. It is not necessary
out the great progress made in this direction; the
andard lathe speaks for itself. It would seem, how-
in most makes of lathes there has been no provision
he wear on the V shear on which the carriage moves.
ear is on these lathes like Fig. 1., the V way of the
ting about two-thirds of the depth. While wear on the
the carriage will be mostly vertical, it will not be so
-shear. If the lathe is turning up some work, the
stance on the V-shear will be at A A, and when bor-
B; consequently in a short time a well developed
n the V shear is soon obtained. By using a clear-
ar as shown in Fig. 2, and having the V-way of the
ear over the edge of the V-shear as shown in Fig. 3,
ill be reduced to a minimum, and leave no shoulder
riage to rock on. This style of V-shear is not new,
as proven it to be superior to the ones in general
seems strange to me that it is not more generally
machine tool workers, not particularly on lathes,
er tables and all parts of machinery having a wear-
. I notice that several makers of lathes are adopting
this clearance style of V-shear, but some of them do not fully clear the edge of the V-shear with the carriage way.



Sections of Lathe Shears.

The principal accessory to the lathe, and one that seems to be sadly overlooked, is the steady rest. Its progress has been like its name—a steady rest. Of course, some finishing touches have been given to it in regard to its design, but its usefulness as a steadying rest is still limited. Its capacity should be equal to swinging over the saddle of the lathe and at the same time it should be rigid enough to support the end of any piece that the lathe could swing. It would seem that some of the present steady rests were more adaptable for gun sights than for steadying heavy revolving pieces in the lathe.

T. B. C.

* * *

## COTTER PINS.

*Editor* MACHINERY:

Recently I observed a peculiar accident, which suggested to me that a more liberal use of cotter pins in engine construction would be an advantage. The accident in question was that of one of the revolving weights of a governor on a Corliss engine coming off and dropping to the floor while the engine was in motion. It appears that the motion of the governor exercised an influence tending to give the weight a revolving motion on its stem, which caused it to unscrew the holding nut, allowing the weight to drop. This apparently had no effect on the speed of the engine, and no damage resulted; but it occurred to me that if the nut had been secured from turning by a pin or its equivalent it would have been safer.

In this connection I recall two serious accidents to large engines, which happened in my presence. In one case a vertical and in the other a horizontal engine were wrecked because the key holding the piston rod in the cross-head came out. One of these engines was new and had been running under load about twenty minutes. In either of these cases, if the end of the key had been drilled and a simple split pin been inserted, which would have cost only a few cents, it would have resulted in a saving of many dollars, because this would have been sufficient to prevent the key getting out. This is a point appreciated by locomotive builders who quite generally employ this inexpensive and most effective safeguard.

A. BEMENT.

* * *

## CONSERVATISM IN MACHINE SHOPS.

*Editor* MACHINERY:

I noticed a brief editorial note in the April issue of MACHINERY on the difficulty experienced by those interested, in obtaining access to the manufacturing establishments in England and the subsequent discovery of bald and ancient practices when such admittance was finally granted. The concluding sentence intimating that such occurrences were not infrequent in this country has often been borne out by the writer's experience in some of his peregrinations around the country in search of a job or when just "rubbering" for information.

One such instance I recall as having occurred right here in New Jersey. Being considerably interested in the product of a well known firm I ventured to ask permission one day to take a look through their establishment, with the idea of possibly picking up some mechanical information which might be of value in the dim and distant future when Perry became a superintendent. To my surprise and chagrin, admittance was promptly and almost savagely denied. It was intimated that they (the firm) were in business for what there was in it and not at all on account of the salubrious conditions. From the latter remark I suppose that their health was meant. Not caring to be turned down in such an unceremonious manner, I managed eventually to win the good graces of the superintendent and at a later visit was duly ushered into the "Holy of Holies." Great Caesar! What a falling away from expected conditions was my experience upon actual realization. The practice was in many instances entirely out of date and a number of jobs in progress were being done in a way that was extremely expensive when compared to what is possible with the improved machinery provided for such work, or unnecessary as is proved by contemporaneous practice.

I was shown with some pride a planer which was being used for planing two heavy castings which were entirely too large and heavy for the capacity of the machine. To handle them, it was necessary to remove the cross-rail and substitute a jim-crack from the housings to support the tool. Of course, the handling of such castings displayed a certain amount of skill and management on the part of the mechanic in charge, especially when it came to oiling the ways, as it was necessary to run the platen back every few minutes to deluge them with oil to prevent cutting. The obvious remedy for this condition of affairs was a larger and better proportioned planer, as the character of their work continually demanded a tool of greater capacity.

A heavy combination machine for doing two operations simultaneously was exhibited as a tool developed and built expressly for their work and reference was made to the attempt of a representative of a well-known mechanical journal to photograph and describe it for the benefit of their readers, and how he was severely turned down. While I have no reason to disbelieve that the machine was developed in this shop, and that at one time it represented a valuable asset, it is now entirely without novelty, as it is being duplicated in the product of a tool-building firm, with many impovements that experience and the suggestions of users have made possible. An ancient boring mill was also cautiously shown as another machine developed and built here. As a relic of bygone times it was interesting, but as part of an equipment liable to be copied by competitors, it was simply ludicrous.

In conversation with the superintendent, who, by the way, is a most worthy man, the idea was gained that whatever the firm have discovered or developed is regarded as their private property, and that no possible good could come by the general admittance of other members of the craft to their shops. The belief was expressed that mechanical journals as a rule were of more detriment to the interests of manufacturers than a help, as they were constantly exposing and giving away secrets that had cost much time and experimental work.

While my experience in the reading of mechanical journals is that much information can be gathered from their columns, I cannot see wherein this information is usually of any material detriment to the shop whose practice is described, unless it be that those responsible for the shop's progress refuse, in their turn, to assimilate the valuable information therein contained which has been gathered from other sources. The interchange of ideas which has been so prevalent among the more progressive shops of America, is one important factor that to-day makes her the leader in the machine tool building trade. The shop superintendent or proprietor who does not assimilate new ideas from extraneous sources, and thereby improve his practice, will surely fall behind the procession unless he be of extraordinary ingenuity and possessed of great mental resources. It is my belief, gathered from quite an extended experience, that the best plan is to freely give of your experience, and in return use that which commends itself to your judgment as being well calculated to improve the quality or increase the quantity of work produced. In this way, and no other, can the average shop keep up to the mark, and as soon as our machine shop proprietors adopt the close Continental method of shop practice, just so soon will they begin to fall behind in the industrial race. (At least this is my humble opinion.) R. P. Perry.

Hoboken, N. J.

* * *

## SPIRAL GEARS.

*Editor* Machinery:

A short time ago I was looking through a gas engine shop in western Pennsylvania. In the course of conversation the subject of spiral gears came up, and the mechanical superintendent stated that formerly they had been in the habit of having the gears cut by outside parties, but that, as he thought the prices charged were very high, he devised a method of casting the gears. The mold was made from a cut pattern, but here came the trouble of pulling the pattern from the mold. This is the way this difficulty was overcome. The metal pattern was placed on a smooth surface and a border put on about an inch and one-half away from the gear and then a casting of babbitt metal was made, making a thin internal gear about one-fourth inch thick. This gear was carefully trued, and placed over the pattern in the sand, then by a careful twisting motion the pattern was pulled from the sand, leaving a perfect mold. The castings were very smooth, required very little trimming and ran very smoothly, and the scale surface, the superintendent informed me, added considerably to the moving qualities of the gear. No doubt, this process is old to some of your older readers, but it may be new to the younger mechanics. F. H. Jackson.

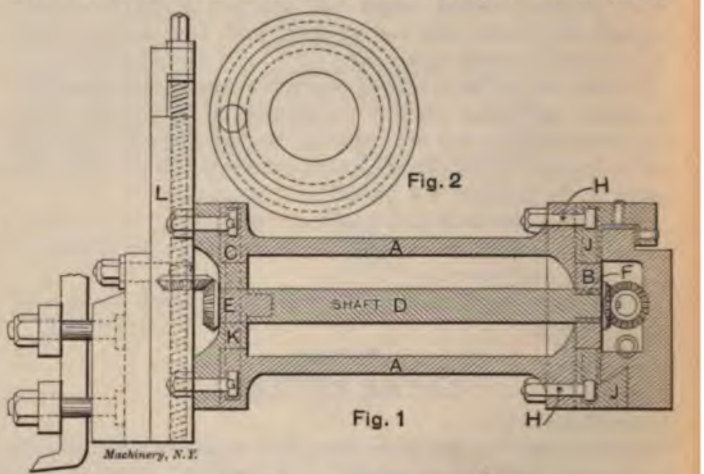
* * *

## EXTENSION TOOL-HOLDER FOR PLANER.

*Editor* Machinery:

I send you a sketch of a rig that will enable a small planer to take in work that it could not do without an extension tool of some kind.

It consists of a cylindrical casting A Fig. 1, an end view of which is shown in Fig. 2 where the dotted lines represent the T-slot cut out to receive the bolt-heads of Fig. 1. This enables the head to be used at any angle. The other end of the casting A has four holes drilled in the flange for the bolts H which secure it to the cross-head J.



Extension Tool-holder for Planer.

The boss B is turned to fit the hole in the cross-head, the other end of A being bored to receive the boss K on which the vertical slide L swivels. The shaft D connects the bevel-gears E and F and enables the down feed to be used with the same facility that it would under ordinary circumstances. This device is rigid and convenient. H. D. J.

Hartford, Conn.

* * *

## THE ADJUSTMENT OF SHAPER SLIDES—FINISHING CORE PRINTS.

*Editor* Machinery:

I have been paying a good deal of attention lately to the ease with which the gibs on machine tools may be adjusted. I am of the opinion that this in a great many cases is a thing too easily done, especially where the gibs are adjusted with blind set screws. One machine that caught my eye was a shaper that had only been in use about six years and was already in a very bad condition. The ram was of the usual style (like Fig. 1) and adjusted with blind set screws. I found the ram in fearfully bad shape, the slide being all cut and scratched. It was caused by the men in the shop using a screw driver on the set screws when their tool happened to be dull or not in good working order.

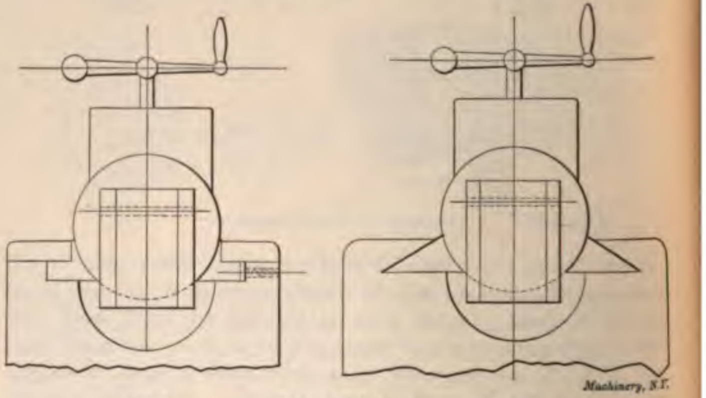


Fig. 1. Shaper Slides. Fig. 2.

In the same shop was a shaper of another style like Fig. 2, with no means of adjustment provided. The slide of this ram ot the least sign of wear and had already been in use teen or fifteen years.

ere are some who will claim that the men should not 1 to touch the adjustment on any machine without the f the foreman, but the writer knows from experience will do this in spite of all orders and in a great many nore or less damage to the machine.

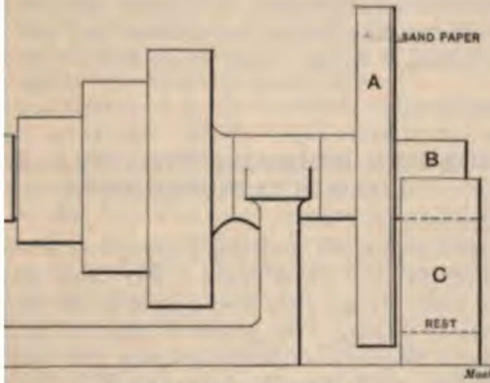


Fig. 3. Finishing Core Prints.

t way of finishing core prints that must be in halves : a disc A about 12 inches in diameter and glued on e of heavy sand paper. Place it in the lathe and work off the print B as shown in sketch Fig 3. It is sur- hat a neat job can be done in about one-tenth the time take for screwing them on the face plate and turning else working them out with a chisel.

C. C. R.

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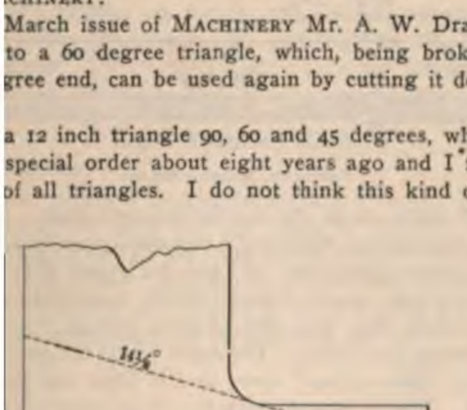
## ILIZING BROKEN TRIANGLES, ETC.

CHINERY:

March issue of MACHINERY Mr. A. W. Draesch calls to a 60 degree triangle, which, being broken off on gree end, can be used again by cutting it down to 45

a 12 inch triangle 90, 60 and 45 degrees, which I had special order about eight years ago and I find it the of all triangles. I do not think this kind of triangle



Available Section from Broken Triangle.

g new for I have seen them used by many draftsmen worked in different parts of the United States. I trade in general has made many of these triangles on der. I had a large 15 inch 45 degree triangle which oken in small pieces and I used the 90 degree corner hown in the enclosed sketch. The 14½ degree angle thing for drawing worms and the 6 degree angle is a y angle for drawing threads on screws. Of course, a uld make the 6 degree angle anything he wishes to wn notion about drawing screw threads.

draftsmen, as a rule, break their triangles in smaller n outlined by Mr. Draesch, so, for this reason, they used to good advantage in the way I have described. re fortunate enough not to have any broken triangles nent with make one out of wood and see how useful

E. W. BENTEL.

ayne, Ind.

## ADVICE CONCERNING PARIS.

*Editor* MACHINERY:

I deem it my duty to call the attention of all Americans who purpose visiting the Paris Exposition of 1900, and more particularly those who intend exhibiting, to the necessity of immediate action if they wish to avoid the annoyance, expense and delay which the unsatisfactory postal and railway service are already occasioning, and which will undoubtedly be more than doubled after the great fair opens its gates. These difficulties are aggravated by the insufficient, unsatisfactory and uncomfortable means of local communication and by the avowed intention of hotel and boarding house proprietors to double their rates in May.

To commence with the railway service: The passenger cars, except those of the first class, are dirty and badly heated, the second class being less desirable than the German third. One can of hot water lying loose on the floor serves to heat a compartment containing eight people on a four and a half hours' run, with the outer air at—11° Centigrade = 12° Fahrenheit. This evil does not, of course, bid fair to affect summer travelers, except that it shows bad management and indifference to passengers' comfort. As regards delays in the service, the train for Calais, which should reach the Gare du Nord or Northern Station at Paris at seven in the evening, got in yesterday at 8:20; a delay of an hour and twenty minutes on a trip which by the time-table should take but four hours; and there is no snow. This is not an exceptional case on this line, as it happens about every two days that there is a delay of from twenty minutes to an hour. The evil is so serious that it is proposed by the French public to have a law passed by which when there is a delay of over ten per cent. of the normal duration of the run the companies shall refund half the price of the ticket.

The recent tail-end collisions, in two successive days, and in one of which there was one person killed and twenty wounded, point to the absence of a block system or of means to enforce its proper superintendence and maintenance. In one of these the second section of an express train left seventeen minutes after the first one, and after losing eight minutes as compared with the first section, succeeded in running into this in a tunnel. The next day a similar tail-end collision occurred. Even this failed to arouse the vigilance of the French railway employes, for a few days after a passenger noticed at a way station that the employe, one of whose duties is to put out the block signal after the passage of the express train, calmly continued to gum labels on baggage. On being asked why he did not put out the block signal for the express, he replied: "Oh, the express has long legs and can take care of itself!"

The freight service is no better. A trunk took nearly four weeks to come from Bremer-haven to Paris; another the same time to come from Braunschweig to Paris.

The postal service in Paris is wretched. Living within three blocks of a post-office, I get my first mail at nine in the morning. A post-card takes from 10 A. M. to 10 P. M. to go from Rue de Rennes to Rue Spontini. I can walk it in an hour and not hurry. Letters post-marked in Dresden at 5 P. M. Monday are delivered in the heart of Paris at 6.30 P. M Thursday. The railway time between the two cities is 26½ hours; and it must be remembered that 6.30 P. M, in Paris is 7.30 P. M. in Dresden, so that the real elapsed time for the letters is 74½ hours. A letter which was plainly addressed by the typewriter was presented at 6 P. M. to the carrier or porter of a building in which the addressee was boarding. The concierge not knowing the name, and not taking the trouble to inquire if there was a newcomer of that name, refused it, but remembered the name and mentioned it to the boarding house keeper. The guest applied in writing the next morning at the post-office, but although the envelope bore the sender's name and address this letter has never turned up. It has not been returned to the writer, and the post-office authorities write that they regret that all efforts to find it have proved unavailing.

The omnibus service is execrable. These vehicles are rackety, noisy, uncomfortable and dirty. They are too low to permit a tall man to stand upright and too narrow to allow long-legged people to sit comfortably or anyone to keep his feet from being trampled on. The "imperial" or upper deck is difficult for even a man to reach, for a woman almost impossible; and in muddy weather a woman's skirt or a man's overcoat tails cannot be protected from the mud on the little spiral staircase. The waiting rooms are small and inconvenient. When I add that the principal streets are torn up by the contractors for the underground railway, and that most of them are cluttered up with building material and with carts of dirt or of building material, I am sure that your readers will agree with me that in making their calculations to have their exhibits in place, or even to see the Exposition within a given time, they must not leave these difficulties and delays out of consideration.

I am not urging people to stay away—on the contrary. Those who do not visit the Exposition will miss the grandest sight of a century. But I do urge all to make their arrangements early about board for themselves, and workmen should put their exhibits in place, and commence as early as possible to get things ready—else they will "get left." ROBERT GRIMSHAW.

Grand Hotel du Palais Royal, Paris.

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## A TOOL CHEST.

*Editor* MACHINERY:

The chest described in this letter is especially adapted for machinists when traveling, being light, convenient and strong. The outside is black walnut, polished and oil-finished. This prevents grease marks, as the box can be cleaned by rubbing it with cotton waste and oil. The drawer and partitions are made from black ash and painted black.

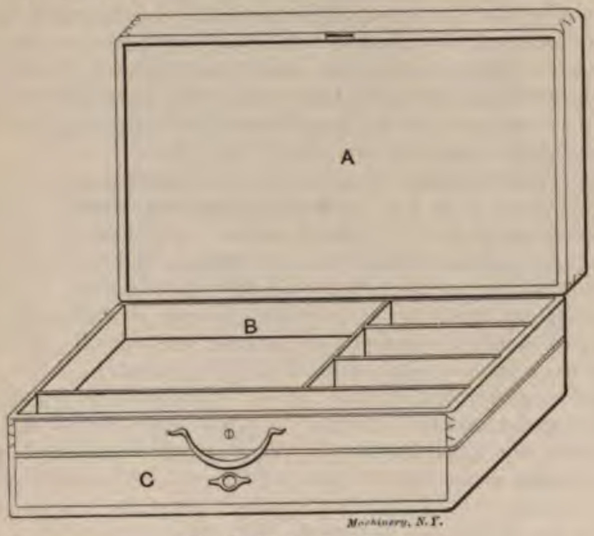

Fig. 1. Handy Tool Chest.

The two accompanying illustrations give a general idea of the box. The outside dimensions are 17" x 10" x 6". The thickness of the outside pieces is ⅜"; the inside pieces are ⅜", 5/16" and ¼". The ends are dovetailed, glued, and strengthened with small screws. The edges are slightly rounded. Fig. 2 illustrates how the partition pieces are joined. They are sunk into the frame or other supports ⅛" and glued.

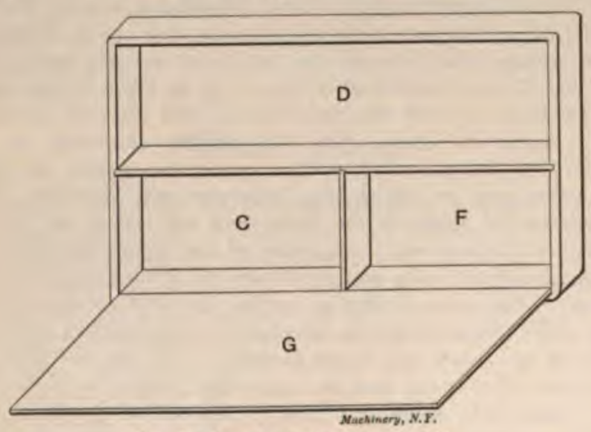

Fig. 2. Arrangement of Tray in Lid.

G in Fig. 2 is the lid for part A in Fig. 1, and it also serves as a writing or drawing board. A is divided into three partitions in which are placed expensive tools, as the micrometer, protractor and 6" square, also several reference books. There is a spring arrangement to lock it with. In Fig. 1, C is a drawer which is intended for heavy tools, such as the hammer, wrench and hack saw. It is divided into two parts by a partition through the center lengthwise. This prevents the heavy tools from crowding and bulging out the sides. It locks by the aid of a small steel rod and spring. To prevent calipers, dividers, scales, etc., from shaking and rattling when traveling, tie them on a big piece of paste-board. The chest when closed resembles a small valise. When traveling it is wrapped in heavy paper and carried by a strap handle. It is easily carried and is saved from rough handling by the baggageman, and also does away with the bother of hiring a truck to get it to the shop.

C. W. SHELLY.

Peterboro, Ont.

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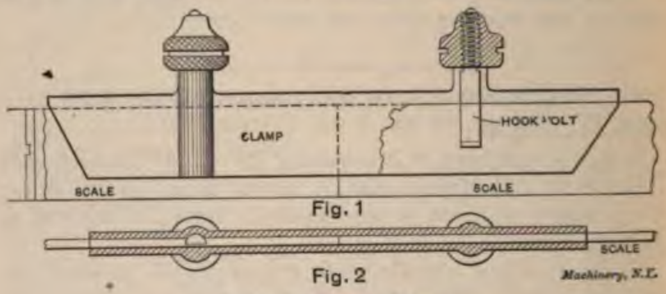
## DEVICE FOR HOLDING TWO SCALES FOR LONG MEASUREMENTS.

*Editor* MACHINERY:

I enclose a sketch of a scale clamp of my own design and also "christened" by me. I have found it very handy when in need of a long scale. It is planed from a piece of cast iron ½" thick by 1" wide by 6" long. The groove is planed to fit the 12" and 18" blades of Starrett's combination square and, with a 12" and 18" scale, the clamp makes a scale 30" long, or with two 18" scales we have one 36" long. The groove is planed with a convex bottom against which the edge of the scale rests. This feature also makes it very easy to true up with a small file to bring the edges of both scales absolutely fair after planing. Most machinists have had use for a long scale at some time or other in their career, and they will find this a very handy device and it will easily go in any machinist's tool chest. The short length of the average machinist's tool chest usually prevents his carrying a scale longer than 18" and the laying of two or more scales on a planer is not always possible or satisfactory. It is, of course, plain that with two of these clamps a scale can be made of almost any length. The space where the two scales butt together is about 1/1000" open, as the light can just be seen through it. This is close enough for all practical purposes. The blades are held by a knurled thumb nut and a half stud to engage the slot in the scale. E. J. B.



Device for Holding Scales.

Dubuque, Iowa.

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## OIL HOLES IN MACHINERY.

*Editor* MACHINERY:

Why do some tool builders make such poor provision for oiling the parts of machines? Within the last few weeks I had several cases of poorly constructed machines of this kind. One of the machines was a 16 foot boring mill. At the time we had a twenty-ton wheel on and were at work boring it (the rim being finished and the bore nearly so), when a whistling noise was heard coming from below the mill. Investigation proved the trouble to be in the journal near the pinion which meets with the large gear underneath the table. This could not be taken apart without removing the wheel and table, which, of course, I did not wish to do, but the part got so hot within half an hour you could not hold your hand on it, and something had to be done quickly. The oil pipes were flooded with oil and judging from the quantity of oil in the pit underneath this bearing, it was certainly not neglected in this respect. Upon closer examination I found that the oil pipes led to an oil reservoir on the outside of the bearing and a wick leading from this up an inch and one-half into an oil hole, poured oil into the pipes on the outside, and after this small reservoir was filled the oil would run into the pit. This wick would supply oil to the bearing in summer, perhaps, but not in winter, and after the first few cold days, no more oil reached that journal. So it ran without oil for a while until it got too dry and began to squeak.

We extracted the wick and squirted oil directly into the hole, but all to no purpose; the groove inside had evidently become choked up and would not let the oil in. I was contemplating drilling a few holes in the side of the bearing to admit oil, when it occurred to me that lamp oil or kerosene might cut its way through; so we dosed it with this for a few minutes, and almost directly it stopped squeaking, to our great relief. Immediately after this we oiled up with machine oil, and in an hour the journal had cooled down to its normal temperature.

The aforesaid pipes were nearly horizontal and they soon became clogged up in zero weather. This alone is bad enough without trying to make it climb the wick when really you have to go to the stove to coax the oil out of the end of a squirt can. Some will say the shop where this happens is behind the age. This I must admit, but nevertheless we must generally put up with things as we find them, until we can improve same. The shop that is so cold that every time you want to oil up you are compelled to spend five minutes or more at the stove or heater must necessarily lose from more sources than frozen oil, because the "oil" in the men gets thick, too, and will not flow as it should. You cannot say anything to a man in a shop like this when you find him at the heater. He would not be there if it was comfortable where he ought to be, and the proper thing to do is to make it as comfortable as possible. This, however, cannot be done very readily in some cases, owing to circumstances.

To return to bearings, I would say that I have had a good many machines apart, especially lathes, and have cut larger oil grooves in the cones and back gears and cut them through at both ends to allow the oil to flow out and also any dirt or accumulation there might be in them. After this I have no more trouble. Just this week I had a drill press cone down which stuck fast on its spindle. This had one measly little oil hole in the center of a bearing ten inches long and the oil groove not cut through within ½" of each end. Well, it's not like that now.

Emsworth, Pa. A. Mertes.

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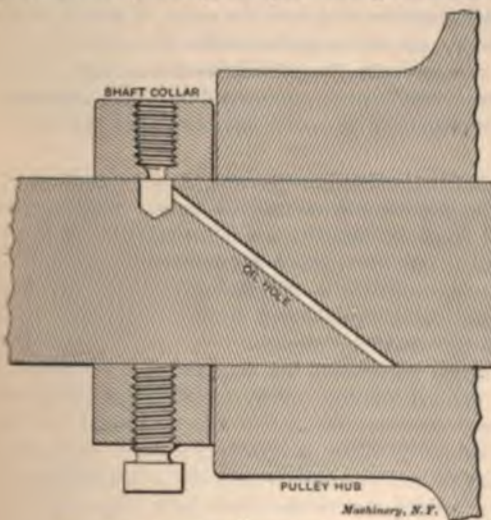
## OILING LOOSE PULLEYS–DEFECTIVE LATHE CONSTRUCTION.

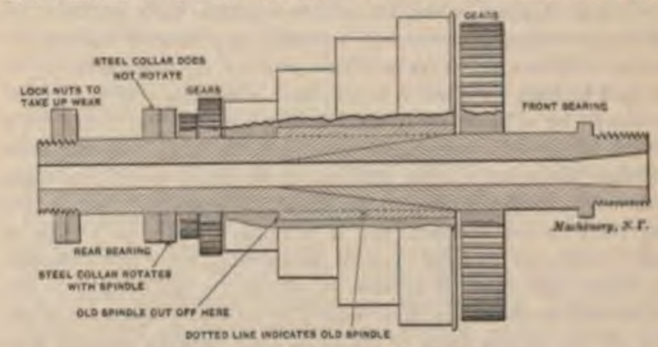
*Editor* Machinery:

The counter shafts with friction pulleys sent out by many builders have a very poor way for oiling the pulley. The pulley is supposed to run all the time that the engine runs. Some have the oil hole tapped for a cup; some have only a hole. They can only be oiled when the engine stops (and then the oil hole may be on the lower side), or by throwing off a belt. The man who does the oiling does not want to put in over time, consequently there is more or less trouble—generally more. I have overcome this by drilling a hole in the collar next to the pulley, some of which I tap and then put in a grease cup. I drill into the shaft a little way, then I take off the collar and drill a small hole diagonally through the shaft, so that the hole comes out near the center of the pulley on the other side. The counter shaft can be oiled any time by just stopping it. I have fixed quite a number this way, and some of them have run 8 or 9 years, and have caused no trouble during that time.



Oiling Arrangement for Loose Pulley.

Before the time of hollow spindle lathes every one used a set screw and lock nut to take up the wear caused by the end thrust. This was good enough for that sort of lathe. Then when hollow spindle lathes were put on the market, they still used the same device, with a hollow set screw. Some few builders, I regret to say, use it even today. This is very bad practice. There is always more or less dirt which gets into the hollow and this dirt will work into the rear bearing and cause trouble. One of the lathes in the shop where I am employed came near being ruined in this way. The lathe, in other respects, was in first class condition. I cleaned the boxes and tinned the inside, then babbitted them with genuine babbitt. Before taking down the lathe, I lined it up and made a box like a pillow box to rest on the inside vees. I then pushed the head towards the tail stock and attached it to the carriage, putting the pillow box where the head was. When I put in my bar one end ran on the dead center and the other had a collar next to the pillow box, with a driving pulley on the outside. Then I set the lathe in front of another lathe in which I had an arbor with a pulley on it. In this way I drove the boring bar and obtained the feed by moving the head-stock along the ways by means of the carriage feed.


GEARS
STEEL COLLAR DOES NOT ROTATE
LOCK NUTS TO TAKE UP WEAR
GEARS
FRONT BEARING
Machinery, N.Y.
REAR BEARING
STEEL COLLAR ROTATES WITH SPINDLE
OLD SPINDLE CUT OFF HERE
DOTTED LINE INDICATES OLD SPINDLE

Method of Repairing Lathe Spindle.

I next repaired the spindle, the first step being to cut it off between the small cone step and the next larger ones. I took a piece of hollow shaft and chucked it in a lathe that has a taper attachment, and bored out one end taper so that it would reach to the gear and not reduce the spindle at the gear. The shaft was a half inch larger in diameter than the spindle, so I turned the spindle to fit; then pressed the two together and put in several small pins to keep them from working apart. I made a new spindle that reaches clear through the rear box with a device to take up the end thrust, and which will not become clogged with dust or dirt.

If all who have been annoyed as I have been would "kick" against the hollow set screw, I think that all lathe makers would eventually abandon them. W. A. Bright.

Decatur, Ill.

* * *

## THE NEED OF PROPORTIONING THE HAMMER TO THE WORK.

*Editor* Machinery:

In going through the average shop, one whose attention happens to be directed to the subject, will be surprised to see how often the wrong tool is used for any given job.

Take for instance, the hammer. A goodly proportion of wielders of this useful tool seem to think a hammer is a hammer, and good to use no matter what kind it may be or on what it is to be used. Now, as a matter of fact, a blow may be struck with any sort of hammer, but there should be some slight consideration paid to the sort of blow adapted to the work. For heavy chipping, riveting, or other work where the work operated upon is rather large, a heavy hammer is generally used, but is it always best to do so? In heavy chipping it is best, because the force of the blow is intended first, to move the chisel, and second to force it into the work, and the hammer should possess sufficient weight to make the force at the chisel edge of the greatest possible effect; but when riveting is to be done, the effect, generally, should be simply to displace or upset the metal near the surface of the rivet.

The heavier the hammer, the more deeply will it affect the object struck. This is well understood by forgemen in the large steel plants where steam hammers of great weight are used in order that the effect may penetrate to the center of the piece being forged. This same principle ought to be applied to the use of hand hammers as well, and to a much greater degree than it is. So in the case of heavy chipping, if a light hammer is used, a large percentage of the effect is expended, not in forcing the chisel into the work, but in actually moving the chisel. Inertia, that property of all matter which resists change of motion—which causes a body to resist being started from a state of rest, or being stopped when in motion—causes each particle, of which the chisel is composed, to resist any motion toward the work. While steel is very dense, and so close grained as to be said to have no fibre, it is true that when one end of a chisel is struck by a hammer, it takes a very minute, but measurable length of time for each particle of steel to be moved, one after another, like a wave, from the head of the chisel toward the edge. While this is taking place in the chisel, the opposite effect is taking place in the hammer, and it is being brought to a state of rest. If the force of the blow of the hammer were just sufficient to cause this wave of motion to travel the full length of the chisel and no more, no effect would be produced upon the work, but all the surplus force of the blow over such an amount goes toward useful work, except such very small amount as is lost in heat and friction, and which need not be considered here.

A large hammer has greater inertia than a small one, and consequently at the edge of the chisel there is more force which may be expanded in moving or cutting the metal in front of the chisel. Or it may be roughly said that the large hammer does not stop so quickly as the small one, and during the excess of time required for stopping, the chisel is getting in its work. In riveting, the result desired is quite the opposite of the above, for the rivet is not to be driven bodily through the hole, but simply spread out on the outer end. Here is where the hammer which is light, compared with the work, is to be used. It delivers a sharp blow, the force of which is quickly expanded, being more largely absorbed by—or rather at—the end of the rivet; for as the wave of motion does not penetrate the rivet with such violence, the effect is chiefly upon or near the surface, and the required upsetting occurs.

These effects are so well known to all shop men that it seems strange that so many are contented to own only one hammer of a "handy" size—which means a size easy to swing, and a size that is too small to do much more than batter the end of a chisel on heavy work, and too large, altogether too large, for the numerous light jobs that abound in all shops and in all kinds of work. FREDERICK M. BUSH.

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## WHAT TO DO AND WHERE TO DO IT.

*Editor* MACHINERY:

I suppose that every machinist, some time in his life, hopes and expects to be the proprietor of a machine shop or manufacturing plant of some kind. The first question is what to make and where to make it?

These questions are very difficult to answer and must, of course, be answered by the intending manufacturer. It is only my idea to give a few suggestions. To begin with, the average machinist has a very limited knowledge of business methods and does not seem to realize the cost of doing business. I have known machinists to declare that the proprietors were making money "hand over fist," when at the same time I was in a position to know that the company was losing every day. Machinists will say, "if the company are losing why don't they shut down?" This, of course, would be the wrong thing to do, as long as there was any hope left, for the trade begins to leave at once and go to other shops that are running. It is a noticeable fact that a customer likes to buy from a busy shop, and, while shut down depreciation and fixed expenses move along with the same regularity. I call attention to these facts for they must be considered after one is in business. There is no escape then, whether they have been previously considered or not.

I would, therefore, suggest that the intending manufacturer secure a position in an office, of his chosen line of business, at any salary. There he could get to see the expense account of the traveling salesman (that would jar him), the bills for advertising, stationery, printed matter, postage and other bills that make up the cost of selling. Then he would begin to realize what it costs to sell goods. Then he might notice a few bills for moulding sand, facing, shovels, riddles, wire brushes, belting, oil, waste, taps, files, twist drills and emery wheels. Then, too, if it happened to be in the fall of the year, there might be a bill there for a new roof and two or three hundred window panes. Sum total these and he would begin to understand the meaning of wear and tear. Then, by going back over the books a short way, he would find where there has been a dividend struck in favor of taxes, insurance, telephone, interest, bad debts and others. These are fixed charges or, at least, they have to be fixed. Then the material bills, taking in everything from pig iron to tacks. He will notice, too, that once, twice or four times a month the timekeeper will hand in a little book that calls for a sum of money on demand, which would take the enthusiasm out of all but the most rugged. This bill can't be put off for sixty days and then settled with a four months' note. Besides there is no discount for cash, but it must be paid for with good cold cash. It must not be forgotten that all of these bills, and more, must be paid for by the goods going out, and, by rights, there should be a little left for the "old man."

After an aspirant has seen some of this side of the business and still thinks he wants to make the attempt, he deserves great credit, and I would not put one stone in his way, and I think he will find the majority willing to help him. If they can't give him anything better they will willingly give what I am now giving, "advice."

Our beginner is supposed to have some means and some reputation in his business and as to character. Without these, the attempt would be useless. He will have to confine himself to some small article, which means small tools for his shop that he could buy with his money and credit. It is not supposed that he would attempt thirty-foot boring mills or suspension bridges, for he might not be able to complete his samples. If he has had experience in die work he would in all probability want to make taps and dies. Unless he has capital enough to equip as well as the present tap and die makers, he had better stay out. If he has, he doesn't have to make them. On this line, I would suggest that he manufacture hand pipe machines to cut 2½" pipe and up, say to 6". There is a fair demand for these machines, and, to my way of thinking, there is not one, of the many on the market, that is made on the right principle. All that I know of turn the die, which is wrong. The pipe should turn to insure good straight threads. Another advantage in turning the pipe is that the cutting-off device can be made more convenient and durable. I think it will be found that the pipe makers and large fitters use the machines that turn the pipe. I see no reason why a small machine cannot be made to turn the pipe, and at a price that would compare with the present small machines. Of course, many will say, "don't make pipe machines, make anything else." If one were proposing to make anything else, the same would be said.

If he has been schooled in engine building he might prefer that line. In this case I would advise keeping out of the small engine trade; but, I do think there are some openings in the larger sizes of high grade. The next move I expect will be made in large engines will be to discard the Corliss valve and adopt the poppet valve and use highly superheated steam. This may sound rank but there is room here for thought.

Then he might understand the machine tool business. In this case if the modern milling machine, with all its improvements and excellent workmanship, is all that it should be, his ideas differ from mine. It never looked just right to me to put a ton or two of metal in a machine with a big overhanging arm, and then put the cutting tool in the center of a long one-inch arbor with a lot of collars on either side. Another idea strikes me that would improve milling machines for some classes of work, and that would be to make the bracket that supports the table removable, something after the style of some shapers, thus allowing work to be bolted to the face of the machine.

Then there are gas engines. For some time past, when a company did not know what to make they would make gas engines. This road looks bright and dark, then gets dark again. Let a beginner start down this pike and he will see the greatest collection of curios known to modern man. He will see and hear of engines with small bore and long stroke, large bore and short stroke, two cycle and four cycle, vertical, horizontal, tandem and at random; one cylinder and many more, pushing on one wrist or many, all kinds of igniting devices from a tiny spark to a long drawn out flame, like that produced by waving a broom that is on fire; or hot tubes or engines that use none of this stuff, but pack the mixture so tight that it fires itself to get out of misery. He will also see all the different kinds of gears, springs, cams, rollers, pins and pegs that have come to us from ages past. If he has never been down this road he had best not start, as it is lined with fire flies, will o' the wisps, illusions and delusions. But, if he has, he may begin to see that there is an opening for gas engines of the larger sizes. Competition on the small sizes is getting so strong that it stings.

There are, no doubt, good openings in the manufacture of certain mining machines, tools and devices. The glass industry is very large and is far behind other manufacturing enterprises, calling for a great number of improved means and methods, for the production and conveyance of the ware; and especially is this true of the plate-glass branch of the glass industry, this branch being the most brutal, dangerous and laborious manufacturing that I know of. With window glass at its present price I believe that the manufacture of a thin ground glass, made by an up-to-date process, could be made to pay large returns. There is undoubtedly a great field for invention in the glass business, and the manufacturers are alive to the fact now as they never were before.

In the foregoing I have given a few suggestions, but I know that a number of persons will object and say that they are no good. I also know that if you were going to start a mint, some people would object and say that there was no money in that.

Good wages are often a drawback to a good mechanic, as they cause him to hesitate in entering an enterprise for himself. It is also true that there are a number of enterprises that a beginner dare not undertake.

Now, then, where is a good place to start? This depends, of course, largely on what we are going to make. If it sells to farmers, make it in the West; if to millionaires, in New York City; if to cotton growers, in the South, and so on. I know of a fine factory in one of the Massachusetts coast towns that has been for sale for some years, and no takers. Who would want a factory with all of the customers on one side of him. This factory, placed about one thousand miles west, would be an excellent investment, because the raw material would be close at hand and the customers on all four sides. The center of population of the United States lies in southern central Indiana and moves west at about the rate of a mile a year. To manufacture an article of general use, say the pipe machine before mentioned, it would be advisable to locate in the north central states. Ohio, Illinois, Michigan and Wisconsin are the coming manufacturing states. In these nearly all of the raw materials are cheap, living expenses are as low as elsewhere, railroad facilities are good, and the customers are all about. CENTRAL WEST.

* * *

The new shops of the Woodward and Powell Planer Co., Worcester, Mass., are 200 feet long, 85 feet wide, with a gallery on two sides and on one end. The engine room is at one end of the shop, the boiler room on one side of the engine room, and the blacksmith shop on the other side of it, with a spur track running into the building. At the other end there is a basement, which is used for a lavatory and coat room for the men. The foreman's office is on the first floor and on the gallery floor are the main offices, and above the main office the drafting room. This building has a monitor, and therefore there are three banks of windows on each side of the building, which gives a great quantity of light. There is a 10-ton traveling electric crane for handling the product. The work in the gallery is brought to the gallery on one end and is delivered by the crane to the floor.

* * *

An interesting experiment in ascertaining the time it takes to start and stop a steamer, states the "Marine Record," was carried out recently. The Merida, a steamship of 2,309 tons, 260 feet in length, 45 feet beam and with a depth of 21 feet, obtained the maximum speed of 14 miles per hour. The full power of the screw was exerted in stopping the vessel by backing, and from the time it was at full speed until the Merida lay motionless in the water was exactly two minutes.

## GAS ENGINE DESIGN.—6.

### THE DESIGN OF BALANCE-WEIGHTS AND FLY-WHEELS

E. W. ROBERTS.

Probably the most effective method of balancing the moving parts of any machine is to attach other moving parts to it that are in every respect the same as those which they are required to balance. The best balanced engine is doubtless that in which there are two cylinders of precisely the same size with the pistons and the connecting rods the same in each engine, in both the matter of proportion and of weight. Then if the crankpins are set 180° apart, the engine is probably as perfectly balanced as it is possible to make it. Setting the crank pins of a gas engine with two cylinders at 180° may not appear to be the proper method of distributing the impulses in the most effective manner, because with this arrangement two explosions must follow each other in the same revolution, and the revolution immediately following will necessarily be an idle one. In a four-cycle engine having an enclosed crank chamber and two cylinders, placing the crank pins on the same center will produce a vacuum in the chamber, and experience has proven that the vacuum is productive of annoying consequences. There are, no doubt, some successful two-cylinder engines with enclosed crank chambers which have the crank pins together. The writer has, however, heard considerable discussion on this subject, and the consensus of opinion seems to be that, for best results, the crank pins of such engines should be set at 180°. It is certainly true that some of the most successful automobile engines are balanced in this manner.

Quite a number of gas engines are constructed with single cylinders, and the only feasible way of balancing such engines is to employ a revolving weight, attached either to the crank web or to the fly-wheel. In some engines the weight is cast on the fly-wheel, or a portion of the fly-wheel is cored out at a point on the same side of the shaft as the pin. The best effect, with the least detriment to the engine, is produced by attaching the balance weight to the crank arm, but this position requires a heavier weight than when the weight is at or near the periphery of the fly-wheel, and the cost of construction makes it the more expensive weight to employ. Of the two methods employed, when the balancing is done in the fly-wheel, the core method is perhaps that to be preferred because of its neater appearance.

In order to balance the moving weights on a single cylinder engine, two factors must be taken into account and dealt with differently. In order to balance an engine having a horizontal cylinder for the vertical rocking effect, it is necessary to balance that portion only which may be considered as rotating. For the horizontal effect, the reciprocating weight should be considered, as well as that which is rotating. Thus for the vertical effect it is necessary to consider that effect only which is due to the crank arms, the crank pin and that portion of the connecting-rod which may be considered as rotating. For the horizontal effect, the above portions of the mechanism, that portion of the rod which may be considered as sliding and the weight of the piston must be considered. If, however, the total horizontal effect be balanced by means of a weight, the engine would still be out of balance. A compromise must therefore be made by balancing but half the effect of the reciprocating parts in addition to the rotating parts, although fairly good results may be obtained by balancing the rotating portions alone. The question of speed is thought by some to be an important factor in the balancing of an engine, but it is of no consequence whatever. The true test of a well balanced engine is to shut off all power and allow the engine to slow down of itself without a load, and to see how long it will run before it stops. Other conditions, including those of lubrication etc., being equal, the better the engine is balanced, the longer it will be before it stops. A well balanced engine will, after the gas has been shut off, show no signs of swaying, even if the foundation bolts are loose. To balance an engine intelligently, it is necessary to know the weights of the crank arms, the crank pin and the piston. Should the engine employ a cross-head and a piston rod, the weights of these parts should also be taken into consideration. It is not a difficult matter to calculate the weights of the pin and the arms from the dimensions of the finished crank shaft, but the connecting-rod and the piston should be weighed. The weight of the crank arms should be taken as acting at their center of gravity, while all other portions of the mechanism should be taken as acting at the center of the crank pin. To find what portion of the rod should be taken as rotating, the rod should be weighed at the larger or crank end while supported on a pivot at the other end.

The plan illustrated in Fig. 24 does away at one time with all computation of the arms, the pin and the rotating portion of the connecting rod. The connecting rod C is put in place on the crank pin and the crank shaft is supported by narrow strips of metal, one of which appears at b. The piston end of the rod is supported by a knife edge at k, the point of support being directly above the center of the brass. The crank end of the rod, together with the brass, is supported by another knife edge at a, which in turn is supported by the block B resting on the platform of the scale S. The whole is now weighed and the weight of block B, of the knife edge a, and of any other accessories is subtracted from the total. The pieces F which support the strips b must, of course, rest upon the floor and not upon the scale. The axial line of the rod should be horizontal, or nearly so, at the time the weight is taken. This net weight is the amount that should be balanced for vertical effect. In order to get the remaining weight of the rod it may be balanced by another scale at k, with a spring balance perhaps. In case it is inconvenient to perform this operation, ⅝ of the weight of the rod may be taken as rotating, without making a serious error.

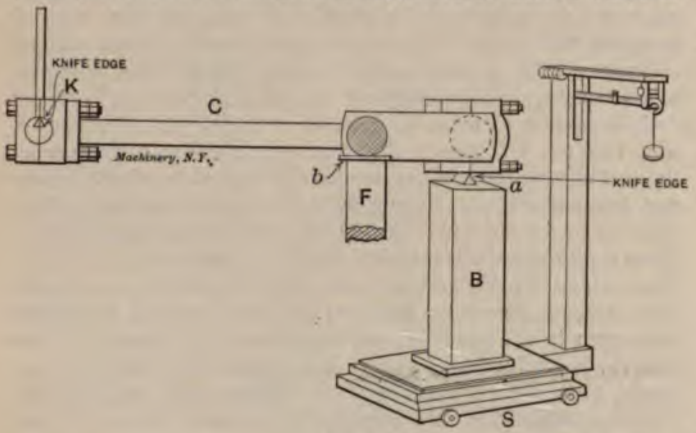

Fig. 24.

The following formulas are those which apply to the two methods in use for calculating the weight of the counter-balance:

Let B = the weight of the counter-balance;
M = the weight of the crank pin = the weight of the rotating portion of the connecting rod;
K = the weight of the reciprocating parts, including the remaining portion of the connecting rod, the piston, and the piston-rod and the crank pin (in engines that employ them);
J = the weight of both crank arms;
m = the crank radius = half the stroke;
j = the distance from the center of gravity of the crank arm to the center of gravity of the crank shaft;
q = the distance from the center of gravity of the balance weight to the center of the crank shaft;

Then $B = \frac{Mm+Jj}{q}$ for balancing the vertical effect alone (35 a);

And $B = \frac{(m\,M + \frac{K}{2}) + J\,j}{q}$ for balancing the vertical effect and half that of the reciprocating weight (35 b).

The shape of the balance weight is generally in accord with the fancy of the designer and does not follow an invariable rule. When a portion of the fly-wheel rim is cored out, the method is usually as shown in Fig. 25. Two core prints are made as shown at p p, and the holes may be afterwards plugged up and smoothed over before the filler is applied, so that they will scarcely show through the paint. The design shown at Fig. 26 is a very neat construction, and the method of attaching the weight to the crank arm is very ingenious, in that it avoids drilling holes in the web. The grooves s s are cast in the weight and planed in the arm, and the opening in the weight is slotted out until it is a good fit to the arm. After the weight is in place, the grooves are filled with babbitt metal through the holes hh. While this arrangement may be objected to in that it requires a little more iron than some other forms, it is simple and has at the same time a very neat appearance.

Still another method is shown in Fig. 27. In this design the balance weight is of elliptical form, and is bolted to the arm by means of the wrought iron straps ww and the cap screws gg. When about to place a balance weight on an engine, it is advisable to weigh it carefully in order to see if it comes up to the calculated weight. This will lead to the discovery of any blowholes that do not make themselves apparent on the surface of the casting. This precaution will save much annoyance and quite often an unnecessary abuse of the designer, when the balance is found to be inadequate. In small engines wherein the room available for the swing of the balance weight is limited, it may be made from lead. The straps ww are cast into the weight.

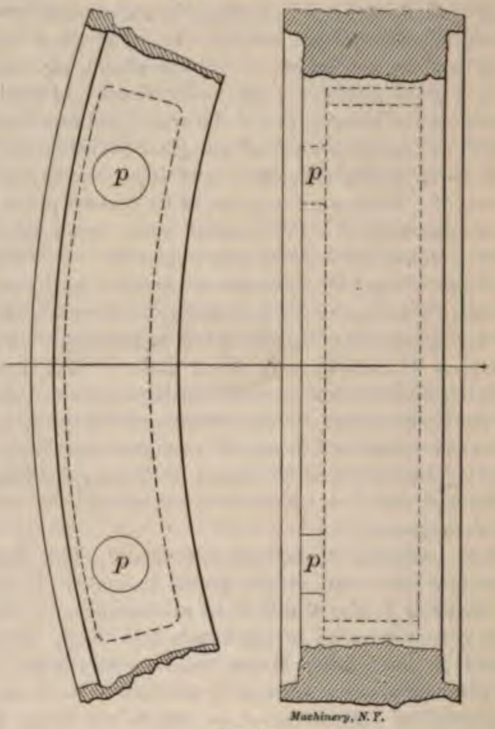

Fig. 25.

The following formula for finding the length of the major axis of an elliptical balance weight is due to Mr. Fred State, for many years a designer with the Dayton Globe Iron Works Co., and is inserted here with his permission:

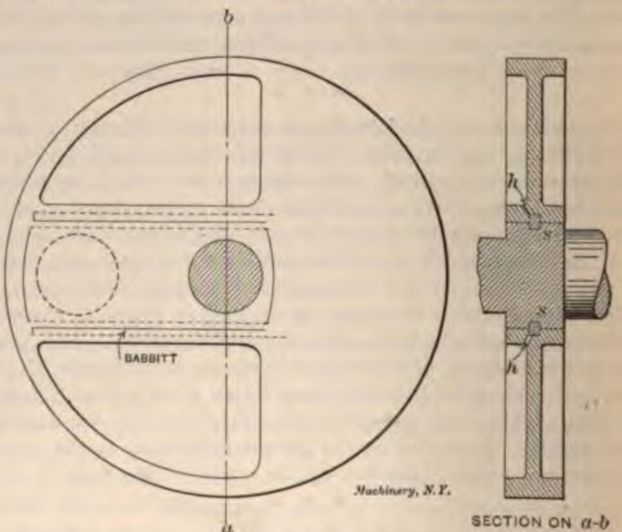

Fig. 26.

Let B = the weight of the balance weight in pounds;
w = the length of the minor axis in inches;
t = the thickness of the weight in inches;
L = the length of the major axis in inches;

Then $L = \frac{4.896\,B}{t\,w.}$ (36)

The application of the above formulas for the design of a balance weight may be shown by the following illustrative example: Suppose that a certain engine has a piston weighing 60 pounds, a connecting rod weighing 40 pounds, a crank pin weighing 6 pounds, and that each crank arm weighs 25 pounds. Let the stroke of the engine be 10 inches, the distance from the center of gravity of the crank arm to the center of the crank shaft 2½ inches, and the distance from the center of the shaft to the center of gravity of the balance weight 4 inches. Formula (35 a) gives the following equation:

$$B = \frac{5\,(25 + 6) + 50 \times 2.5}{4} = 90 \text{ pounds nearly.}$$

As two balance weights are usually employed, the weight of each would be 45 pounds. Note that in the above, ⅝ of the weight of the connecting rod has been considered as rotating. Applying formula (35 b), the equation becomes:

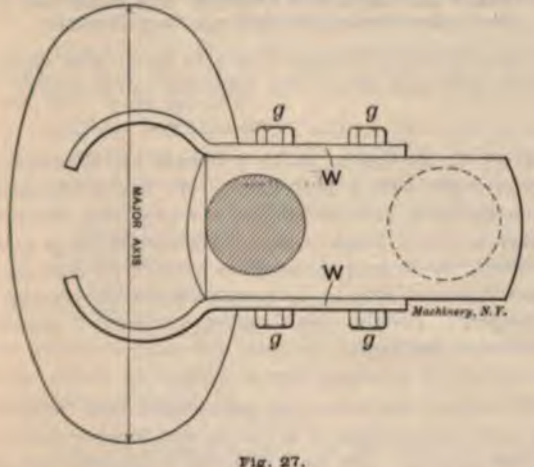

Fig. 27.

$$B = \frac{5\left(6 + 25 + \dfrac{60 \times 15}{2}\right) + 50 \times 2.5}{4} = 114 \text{ pounds nearly.}$$

and the weight of one balance weight will be 57 pounds. The above example should not be considered as showing the difference in results that would be obtained in the use of the above formulas in actual practice, for the reason that the writer has chosen the weights of the various parts at random, and not from actual data.

Taking the formula for an elliptical balance weight, and assuming the thickness of the weight to be 2¼ inches and the minor axis to be 7 inches, formula (36) becomes, with $B = 45$ pounds:

$$L = \frac{4.896 \times 45}{2.25 \times 7} = 14 \text{ inches nearly.}$$

If the writer's experience will count for anything, the fly-wheel is as little understood as any part of the engine, and the formulas for its design which have been published seem to add to the confusion. Why this is so I will leave to the reader to determine, for many of these formulas are excellent and give good results in practice. The most confusing thing about them is that they leave the designer in the dark about the co-efficient to be employed for engines designed for the different classes of work. The writer has computed the co-efficients employed by some of the most successful designers and finds that they agree very closely with those given by Professor Unwin in his admirable work on "Machine Design." In calculating the weight of the fly-wheel, the effect of the fly-wheel arms is not considered and the effective weight is taken as that in the rim of the wheel. For the calculation of this weight it is perhaps the more correct method to lay out a diagram showing the effect of the impulse upon the crank pin and also the effect of the moving parts at the various portions of the stroke. For the requirements of the drafting room these refinements are, in the writer's opinion, scarcely necessary, for the reason that once a basic formula is found, the construction of the diagrams will be found to bring about a result that differs but little from the result obtained by the use of the formula. The following formula for a four-cycle engine appears to give results which are sanctioned by good practice:

Let $W$ = the weight of the fly-wheel rim in pounds;
$f$ = the diameter of the fly-wheel at the center of gravity of the rim, in inches;
$N$ = the r. p. m. of the crank shaft;
$E$ = the co-efficient of unsteadiness permissible;

Then $W = \dfrac{\text{I. H. P.} \times 111{,}600{,}000{,}000}{f^2 N^3 E}$ (37) when an impulse occurs at every fourth stroke. If the I. H. P. (indicated horse power) is that of the engine when exploding less frequently, the value of the figure in the numerator must be increased in proportion. It is well, however, to compute the weight of the fly-wheel for the maximum power of the engine. If the power is taken as that when the engine is exploding at every eighth stroke, as with a hit-and-miss governor at half power, the weight found by the above formula should be doubled. As the power is half that of the engine, the operation brings the weight to the same as that when computed at full power. If the engine is controlled by a governor that reduces the strength of the impulse without cutting out any impulses, the computation should, for powers less than the full power of the engine, be made by the use of the above formula as it stands.

The following are the values of E as given by Professor Unwin, with the addition of a constant for marine practice which the writer has deduced from tables in his possession.

| | |
|---|---|
| For marine engines | .15 |
| For pumping water and all ordinary requirements | .05 |
| For driving machine tools | .03 |
| For driving textile machinery | .025 |
| For driving dynamos | .02 |
| For driving spinning machinery | .01 |

Quite frequently the use of a very heavy fly-wheel on the crank shaft of the engine is avoided by employing a fly-wheel on a jack shaft, on the armature shaft of the dynamo, or on both, when the engine is used for dynamo driving. As the weight of the fly-wheel is in inverse proportion to the square of its diameter at the center of gravity and to the cube of the r. p. m., any increase in the diameter of the wheel or in the speed of the engine will make a marked difference in the weight of the fly-wheel required. The writer knows of at least one manufacturer who runs his engines at an increase of speed over that employed for ordinary purposes, when the engine is to be employed for driving a dynamo. The speed of the "electric light" engine is made nearly double that of the same engine when used for ordinary purposes. A double advantage is gained by this increase in speed. The fly-wheel is not only reduced in weight, but the power of the engine is increased in a direct ratio with the speed and a much lighter engine may be built for the same service. In spite of the many assertions to the contrary, the limit of speed in the gas engine has by no means been reached, and it is steadily advancing with improved methods of construction and design. The writer knows of a large engine now under way in the shops of a prominent manufacturer, which is designed to run at a piston speed of 1,000 feet per minute.

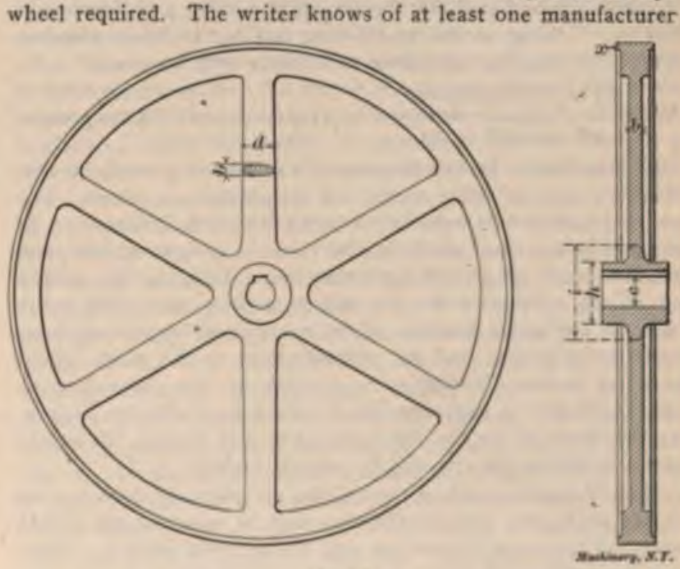

Fig. 28.

The diameter of the fly-wheel is usually from four to five times the stroke of the engine. It is seldom that the latter ratio is exceeded. The limit of peripheral speed is given by good authorities as 6,000 feet per minute. The following formula for the limit of speed is that given in Kent's Mechanical Engineers' Pocket-Book:

Let D = the outside diameter of the fly-wheel in feet;
N = the r. p. m.;

$$\text{Then } D = \frac{1910}{N} \qquad (38).$$

The general proportions of the fly-wheel may be shown by the aid of Fig. 28. The general proportions of the rim are omitted, as they depend to a great extent upon the weight required in each particular case.

Let c = the diameter of the crank shaft.;
Then h = 2c;
i = 3c;
d = .8c to 1.2c;
b = .4d (39)

It appears to be quite the universal practice to employ six spokes for the fly-wheel of a gas engine, although in very large engines eight and even ten spokes may occasionally be found. The arms are given a slight taper of from ¼ to ⅜ inches per foot of length, the dimensions d and b being those at the middle of its length. The length of the hub should be at least 1.5 times the diameter of the shaft, the average ratio being 2c and in some cases it is as high as 2.5c.

In order to show the application of these formulas, the writer will compute the dimensions of a fly-wheel for a fifty horsepower single-cylinder four-cycle engine. With a mechanical efficiency of 80%, the I. H. P. of this engine would be 63 horsepower. The dimensions of the engine would be 16" x 24" with a speed of 150 r. p. m. Assuming the outside diameter of the fly-wheel as four times the stroke, it should be 96 inches, or 8 feet. Assume that the depth of the rim section will be 6 inches, and the center of gravity of the rim section would be 3 inches from the outside of the wheel,[*] giving the diameter of the center of gravity as 90 inches. A preliminary calculation for the weight of the rim may now be made and the depth may be changed if it be found that the rim will be either too wide or too narrow. Taking as the co-efficient that for ordinary requirements, the equation according to formula (38) becomes:

$$W = \frac{63 \times 111{,}600{,}000{,}000}{90^2 \times (150)^3 \times .05} = 5{,}144 \text{ pounds, call it } 5{,}140 \text{ pounds.}$$

As there are to be two fly-wheels, it is necessary to divide this result by two in order to get the weight of one wheel. The weight of one wheel would then be 2,570 pounds in the rim. In computing the dimensions of the rim, the weight of cast iron may be taken .26 pound per cubic inch. Dividing the weight by .26 the volume of the rim will be 2,570 ÷ .26 = 9,885 cubic inches. The mean diameter of the rim section has already been taken as 90 inches, and the circumference at this point would be 282.7 inches. Dividing the volume by the circumference, 9,885 ÷ 282.7 = 35 square inches for the area of the rim section. As the depth of the rim has been taken as 6 inches, this would give a width for the rim of 5.83, say 5¾ inches.

Since there is usually a flare at the periphery of the wheel as shown at X, the body of the rim may be taken at 5½ inches wide and the extra ¼ inch put into the widened portion. Making the depth of the flare 1 inch, the added width must be six times ¼ or 1½ inches, which will give ¾ inch on each side, and the total width of the rim at the outside will be 7 inches. The reader should note that this is a much lighter fly-wheel than is used for driving manufacturing machinery, and that it is only suitable for an engine which is pumping water or driving machinery in which steady speed is of little consequence.

For the proportions of the hub and the spokes, taking 6¼ inches as the diameter of the crank shaft, the diameter (h) of the hub will be 12½ inches, i is 3c or 18¾ inches, and d may be taken as equal to c or 6¼ inches. Applying formula (39) to find b, we have

$$b = .4 \times 6.25 = 2.5 \text{ inches, nearly.}$$

The length of the hub will be 12 ½ inches, or twice the diameter of the crank shaft. The arm is nearly always made of an elliptical cross-section as is indicated in the figure. The writer has followed the proportions given by the above results in the design of the fly-wheel shown in Fig. 26.

Errata.—In formulas (26a), (26b) and (26c), article No. 5 of this series, which appeared in the April issue, the index has been omitted from the radical sign. The error makes it appear that the square root of m should be taken while the fourth root is that intended.
E. W. R.

* * *

## HOW AND WHY.

### A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

**Give all details and name and address. The latter are for our own convenience and will not be published.**

If the subscriber in Kentucky who asks about lathe speeds will send us his name and address, we will reply to his inquiry.

53.—R. C. G. desires to make a burner for vaporizing and burning kerosene with a blue flame. He has tried running a pipe from the tank and so bending the pipe that the burning vapor from a row of holes in the pipe heats the oil in a part of the pipe above the flame and vaporizes it ready for burning. He complains, however, that he does not secure a hot enough flame for his purpose. Possibly some reader can suggest proportions for a burner of this type.

54.—We submit the following questions to our subscribers: 1. What is the best method of browning and blueing steel to prevent it from rusting. The steel is occasionally subjected to wet weather, as for example, in the case of gun barrels. 2. A cement for fastening leather to cast iron. The enquirer has tried fish glue, but does not find it satisfactory. He wishes to cover friction pulleys with leather, and although he allows for stretching and rivets the leather on the pulley in places, it troubles by pulling off.

55.—H. V. D.: In a number of mechanical engineers' reference books I find the thickness or depth of the heads of U. S. Standard bolts given 1/16th inch less than the diameter of the bolt in each case, and in a number of other books the depth is given as ¾ the diameter of the bolt plus 1/16th inch, which gives a thinner head than by the other formula. I also find each of these referred to as the U. S. Standard, the Franklin Institute Standard and the Sellers Standard. Can you tell me which of the two proportions is correct for bolt heads and what variation there is, if any, in the standards of the United States, of Franklin Institute and of Sellers?

A.—Our understanding of the questions is as follows: In 1864 William Sellers read a paper before the Franklin Institute of Philadelphia upon a "System of Screw-threads and Nuts" which gave the results of his experience. In the same year a committee of the Franklin Institute recommended the adoption by that institution of the Sellers system, which was done. At this time bar iron and steel were not made in the variety of sizes that can now be obtained, and it was thought best to adopt sizes for finished bolt heads and nuts 1/16 inch smaller than the rough heads and nuts. Accordingly, the distance across flats for rough heads and nuts was made 1½ times the diameter plus ⅛ inch and for finished bolts and nuts, 1/16" smaller. The same plan was followed with regard to the depth or thickness of heads and nuts, and both heads and nuts were made equal to the diameter of the bolt in depth for rough bolts and 1/16" less for finished. Later, the Sellers system of screw threads was adopted as standard by the army and navy departments of the United States government, but changes were made in the proportions of the heads and nuts. The distances across flats was made equal to 1½ times the diameter of bolt, plus ⅛ inch, for both rough and finished bolts; the depth of the nut was made equal to the diameter of the bolt for both rough and finished stock, and the depth or thickness of the head was changed to ¾ diameter of bolt plus 1/16 inch for both rough and finished. Thus, in making bolts and nuts to conform to the United States standard, stock must be used that is a little oversize, if they are to be finished, and the heads will be thinner than called for by the Sellers standard.

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[*] Although the center of gravity of a ring lies a short distance outside of the line midway between its inner and outer circumference, the assumption made does not involve an error of consequence.

56.—In the April number we submitted two questions to our subscribers. One was about fusible solder to solder babbitt letters to cast iron. A contributor who wishes to go by the name of "S. Wrench" says in regard to this: "These letters are seldom made of babbitt, but of white metal, which fuses easily when touched with a very hot iron, and it is difficult to do a neat job with it. First file the casting bright, and then tin with zinc chloride and use the following composition for a fusible solder: Tin 3 parts, lead 4 parts and bismuth 2 parts, using zinc chloride as a flux. Or, if preferred, I can send a recipe for cold soldering.

"In my practice I find the easiest and best way to attach such letters to cast iron patterns is to fasten them in position with wax and then drill and pin them with brass wire."

The other question that we submitted asked for a solution for coloring bright brass a fast dull black. To this our correspondent who replied to the first question says that platinum chloride rubbed in with the hand and then washed and polished with oil and leather is about the best process, but lamp black and shellac, mixed thin, make a good surface where the article does not have to be handled.

A. E. Whiting, Ashtabula, O., and a subscriber at Ottawa, Can., both recommend another recipe, which Mr. Whiting says is used by French instrument makers. The metal should be dipped in a mixture of equal parts of the following solutions:

| | | |
|---|---|---|
| No. 1. | Silver Nitrate | 40 grains. |
| | Water | 100 minims. |
| No. 2. | Copper Nitrate | 40 grains. |
| | Water | 100 minims. |

When removed from this solution it should be allowed to dry and then should be uniformly and gradually heated until it assumes the desired black.

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57.—F. F.: To settle a dispute, please define lead and pitch, as used in connection with a screw. It is agreed by all that with single-threaded screws the terms are synonymous, but there is a difference of opinion when it comes to multiple-threaded screws. Do lead and pitch both mean the same thing in this case, or does one refer to the longitudinal distance from thread to thread and the other to the distance that the screw would advance in one turn, and if so to which term should the latter definition be given?

A.—Lead invariably means the distance that the screw would advance in one turn. The term "lead" means to guide, or help along, and in the case of a lathe lead screw, for example, the lead is the distance that the carriage is helped or moved along in one turn of the screw. This definition would hold whether the screw were single—or multiple-threaded. With regard to the term "pitch," different dictionaries define it differently, but the new Standard dictionary says it is "the amount of the advance of a screw thread in a single turn." According to this the term is synonymous with lead, and we believe it is almost universally the custom to so consider it.

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58.—A subscriber wants to know how to calculate the weight of a fly-wheel for a gasolene engine for driving an automobile. He thinks the wheels used for stationary practice are too heavy, since the inertia of the carriage should act in a measure to help the engine just as a fly-wheel would help it.

A.—We referred this question to Mr. Arthur Herschmann, New York, who replies as follows: "He should not rely on the inertia of the wagon, and if he is not careful it will do him more harm than good. When this inertia is most wanted, the wagon is at rest, that is when stalled on a dirty road or when ascending a hill.

"In such cases nothing but a very heavy fly-wheel will do the business. I had many a sad experience before I found this out, and the clutch which you must throw in when starting the wagon can be less carefully operated when the fly-wheel is heavy. The wagon will "buck" like a horse, and the fly-wheel will do what much more powerful engines would probably fail to do.

"Weight of fly-wheel in tons should equal I. H. P. × 14,109,209 ÷ square diameter in feet × cube of highest speed. Thus, say we have a 10 H. P. engine, maximum number revolutions 600. Fly-wheel two feet diameter. Then

$$\frac{10 \times 14{,}109{,}209}{4 \times 216{,}000{,}000} = 0.163 \text{ tons} = 326 \text{ pounds.}$$

"Probably I should take chances, even on a single cylinder machine, and make the wheel much lighter. Twin cylinder engines are almost universally employed and call, of course, for a lighter wheel, and to an extent according to the way you couple up. If the cylinders are side by side and act on the same crank the engine will be out of balance, but there will be only one idle stroke between each explosion. If there are two cylinders side by side, acting on separate cranks at an angle of 180 degrees, there will be alternately two power strokes and two idle strokes. If with the same arrangement of cranks the cylinders are placed opposite to each other, there will be alternately an idle and an explosion stroke, and the engine will be in balance."

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59.—Reader: Will you kindly give me some information regarding the propeller for a small launch. We have a boat 20 feet long and 5 feet wide, drawing about 22 inches of water. The power is a gas engine 4½" x 5". We use a reversible blade propeller, 13 inches in diameter, but it is too small, the engine running up as high as 600 revolutions per minute, making the engine so hot that it explodes of its own heat, often back-firing. What size screw would hold it down to about 400 revolutions per minute? Suppose we should take the same blades we have, and put them on a hub of larger diameter, would it answer as well as a larger blade on an old hub? Would three blades be more effective than two blades? 2. Can you give me any information on the jump-spark method of gas engine ignition? Is it effective? Why is it not more used by gas engine makers?

A.—No mention is made of the class of engine, whether it is a two- or a four-cycle. If a two-cycle engine, as we presume it is, use a 16" 3-blade propeller or an 18" 2-blade. The advantage of a 3-blade propeller is that it will start the boat more quickly and is more effective when towing than the 2-blade. It often happens that a boat with 4-bladed screw will lose two opposite blades without any noticeable difference in its behavior after the vessel is under way. Very often a 2-bladed propeller is speedier than either a 3- or a 4-bladed screw. We do not advise making the change you suggest, but suggest trying a larger screw.

2. The jump spark method has been brought into favor since the advent of the automobile. It is the most effective method of igniting gas engines running at high speeds. It is considered by many to be the most up-to-date method of igniting, and it will probably find favor with builders of the slower speed engines as soon as they find out how to master the difficulties that accompany its use. One piece of pertinent advice we would offer the experimenter with the jump-spark, is not to attempt to build your own coil, but buy it of a maker who has the necessary experience and skill at his command. Insulate both electrodes and make the surface of insulating material (that it is necessary for the carbon to bridge across before making a short circuit) as large as the space will permit. Use about a half-inch-spark coil and place the terminals so that the air-gap between them is not over ⅛ inch. This will make the spark a hot one and strong enough to prevent bridging between the terminals. It should be remembered that it is more difficult to insulate for the high voltage necessary with this spark and that the best materials and the best of care in their manipulation should be used when insulating the ignition plug. Mica and porcelain are good insulators, while asbestos is practically useless. The porcelain should be glazed. If it is intended to dispense with the vibrator and to use the induction of a single make and break in the primary for the spark, it should be remembered that the spark produced when the primary circuit is broken is much stronger than that when it is closed, and only this spark should be depended upon for ignition. If the engine is to run at a high speed, so design the switch that it will keep the circuit closed long enough to establish the necessary amount of magnetism in the core of the coil. If the spark proves to be a weak one, and other conditions are right, look to the switch for your trouble. When purchasing a coil, buy one that has been designed for the purpose and not one of the variety sold at toy stores. There are several on the market built expressly for gas engine ignition.

E. W. Roberts.

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60.—S. T. W.: Will you kindly give me the formulas for the following problems: 1. Two weights of 10 pounds each are hung, one on each end of a straight lever 6 feet long, the lever weighing 5 pounds. The lever thus weighted balances at a point three inches from the center. Find its center of gravity. 2. In a lever of the third class 10 feet long a force of 50 pounds 6 feet from the fulcrum balances a weight of 25 pounds 10 feet from the fulcrum. What is the weight of the lever? 3. If a body is thrown upward with a velocity of 644 feet per second, what will be its velocity at the end of 28 seconds and in what direction?

A.—Questions of this description are easily answered by the aid of the formulas contained in any manual of elementary mechanics. The first two are taken from several relating to levers that S. T. W. has sent us and these have been selected as representative of the whole. All lever problems are easily solved by the principle of moments which is that the forces tending to turn a body in one direction about a pivot times the perpendicular distances from the pivot to the lines of directions of these forces must equal the products of the forces tending to turn the body in the opposite direction and their perpendicular distances from the pivot. Applying this to the first question, we have: 1. Forces tending to turn the lever in a left-hand direction about the fulcrum are a weight of 10 pounds and the weight of the lever, which a little consideration will show must act at the left of the fulcrum to balance the lever and weights. The only force tending to right-hand rotation is the right-hand weight of 10 pounds. Let x be the distance in inches from the center of gravity, at which the weight of the lever acts, to the fulcrum. Taking into account the distances at which the other forces act, we get the equation, $10 \times 33 + 5x = 10 \times 39$, or $330 + 5x = 390$ and $5x = 60$, x 12 inches. 2. In the second example the dimensions can be taken in feet, since there are no odd inches to be considered. Assuming that the center of gravity of the lever comes at its center and placing opposing moments equal to each other, $50 \times 6 = 25 \times 10 + 5W$, where W equals weight of lever, $5W = 50$, $W = 10$ pounds. 3. Since the retarding effect of gravity is at the rate of 32.2 feet per second, for each second, a body starting upward with a velocity of 644 feet per second would come to a stop and start downward again at the end of $644 \div 32.2 = 20$ seconds. It would then have 8 seconds in which to fall and in that time it would acquire a velocity of $8 \times 32.2 = 257.6$ feet per second.

61.—F. G.: What book will give the most information on batteries? 2. How can I magnetize a permanent horseshoe magnet? 3.—How can hard rubber be turned and polished in a lathe?

A.—Carhart's Primary Batteries. Price, $1.50. 2.—The best way to make a strong permanent magnet is to wind around each leg several thousand turns of fine magnet wire, and then pass a current obtained from half a dozen battery cells through the coil for two or three seconds. The wire on the two legs must be so connected that if the bar were straightened out both coils would be wound in the same direction. 3.—Turn in a fast running lathe, the higher the speed the better. Use a sharp tool, sharpened on a fine oil stone, and polish with a piece of felt or flannel; or better yet, use a diamond for cutting.

* * *

## SHOP TERMS ILLUSTRATED.

OVER-TIME.

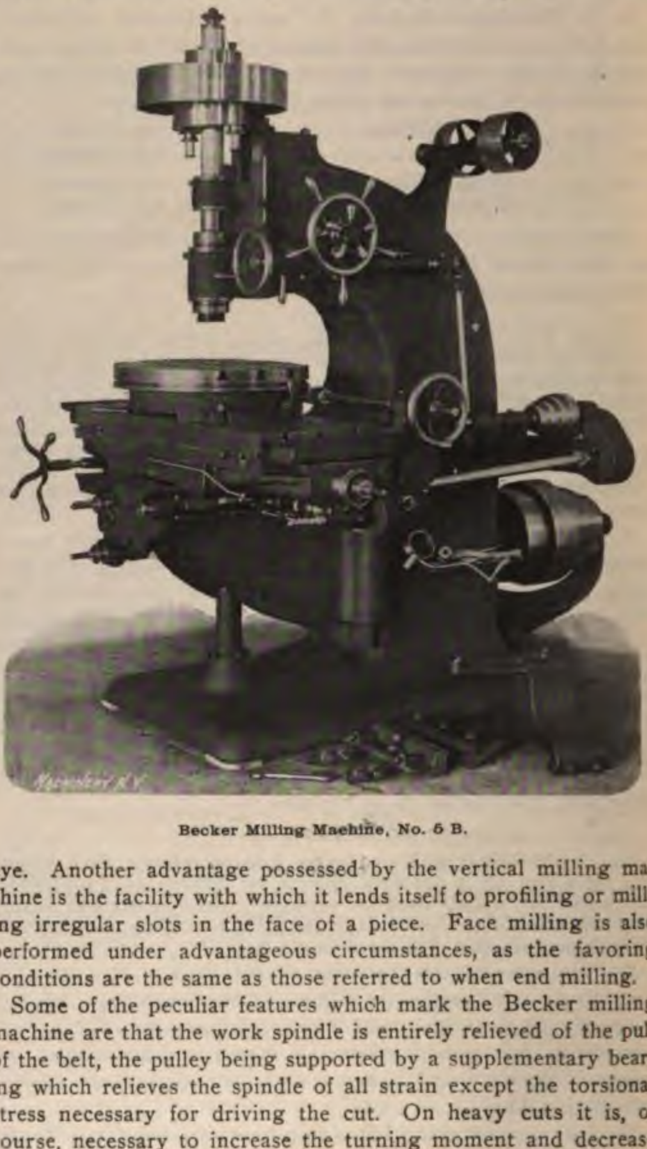
## NEW TOOLS OF THE MONTH.

**Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.**

### NEW BECKER-BRAINARD MILLING MACHINE.

The accompanying half-tone shows a new vertical milling machine recently brought out by the Becker-Brainard Milling Machine Company, Hyde Park, Mass. This machine is known as No. 5B, being an intermediate size between the regular No. 5 and No. 6, and is considered as the best size for most shops, as it is neither too heavy nor too light to meet the requirements of the average shop.

The general usefulness of the vertical milling machine is being emphasized more and more from year to year as users of these tools learn to appreciate their peculiar advantages. The useful end-mill can be used to far greater advantage with a vertical spindle than on one that is horizontal, since the work is better supported in this position than is usually possible with the horizontal machine, and the operator can better follow it with his eye. Another advantage possessed by the vertical milling machine is the facility with which it lends itself to profiling or milling irregular slots in the face of a piece. Face milling is also performed under advantageous circumstances, as the favoring conditions are the same as those referred to when end milling.



Becker Milling Machine, No. 5 B.

Some of the peculiar features which mark the Becker milling machine are that the work spindle is entirely relieved of the pull of the belt, the pulley being supported by a supplementary bearing which relieves the spindle of all strain except the torsional stress necessary for driving the cut. On heavy cuts it is, of course, necessary to increase the turning moment and decrease the speed of rotation, which is accomplished with back gears, but in order to equalize the driving stress and prevent side action, the back gears are applied in duplicate on opposite sides of the vertical spindle. The bearings of the spindle are bronze bushings fitted in taper holes and split on one side so that adjustment is effected by longitudinal movement of the bushings relative to the frame. The spindle is bored to the Brown & Sharpe No. 11 taper and the milling cutters are secured by a draw-bar through the spindle, which can be seen projecting from the upper end.

The head carrying the spindle has a vertical travel of 9", which may be either automatic or by hand. An automatic stop is provided which will throw out the vertical feed at any point, an essential feature in vertical boring. The platen is 51½" long by

14" wide and has an automatic feed of 42" in either direction. The saddle carrying the platen is of the same length as the platen and also has an automatic feed of 16" in both directions. The knee supporting the saddle and platen has automatic feed.

The machine is supplied with a rotary table 22" in diameter having automatic feed in either direction. The extreme distance between the spindle and rotary table is 16" and between the spindle and platen without rotary table, 21". The tables have eight feed changes for any spindle speed and the rotary table has sixteen changes which enable a close approximation to be maintained for the various peripheral speeds of the rotating work, which occur on account of different distances from the center of rotation of the work table. Thus a certain angular velocity might give the correct feed for a piece being machined at a point 6" from the center of the rotary table, but the angular velocity would necessarily be only one-half as great for the same feed as a radius of 12".

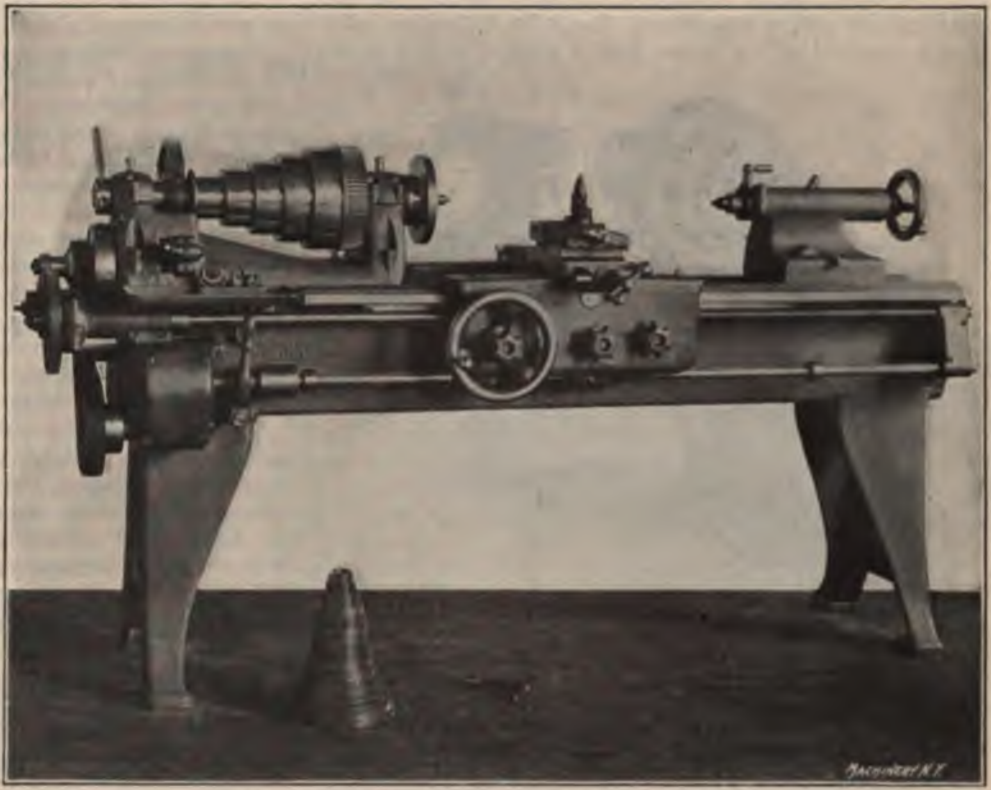
For supporting long and slender cutters, an arbor support is provided which is attached to the knee and used with the rotary table removed.

The machine is provided with an automatic oil pump and connections and a two-speed countershaft which has a ratio between the two speeds of 4 to 1, thus enabling a wide range of speed to be obtained without shifting the belt on the cone pulley. We are informed that the net weight of the machine is 4,560 pounds.

### PRATT & WHITNEY MANUFACTURING LATHE.

The lathe shown in the cut herewith, is of improved design, having a number of mechanical features which commend it for manufacturing purposes. The aim has been to incorporate in it only features of practical value and to simplify the construction wherever possible. The bed is made of a tubular cross-section which is well calculated to resist torsional stress. A comparatively new feature in American practice is the employment of flat and V-ways, by which construction considerable gain in strength to the carriage is obtained together with an absence of the tendency to cramp, as is quite noted where two vees are used. The ways for the carriage consist of one vee in front and a flat way at the back, while the arrangement for the tail-stock is reversed, the flat way being in front and the V-way at the back. By this combination, cutting away of the carriage, at the point where the most strength is needed to resist the pressure on the tool, is avoided.

The spindle is made from high grade steel with the bearings accurately ground and fitted to babbitt bearings. It has a 1.3" hole through it and has a bearing 2 7-16" x 4" in the front box. The carriage is gibbed front and back and the apron is made double, so that the shafts supporting the feed gearing are all supported at both ends. For turning, a feed rod is provided, driven by a two-speed cone. The belt driving it is broad and an idler is provided for taking up the slack, thus providing means for increasing the tension when necessary and doing away with the continual cutting and relacing of the feed belt. Both longitudinal and cross feeds are operated by friction clutches and worm gearing. The worms are hardened and run continually in oil. Automatic feed stops are provided for the longitudinal movement of the carriage. For screw cutting, an independent screw is provided which, with the gearing provided, will cut all ordinary threads from 2 to 92, including 11½. Translating gears are provided for cutting metric threads with the English lead screw or a metric lead screw can be had, also with translating gears, by which ordinary threads from 2 to 22 can be cut, including 11½.

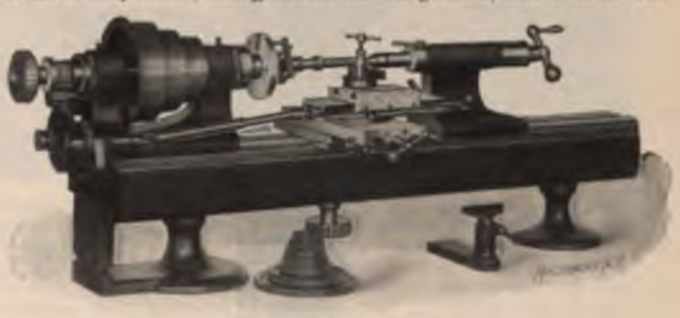

A Heavy 14-inch Lathe of New Design.

A taper attachment is provided which can be attached to the cross-slide by clamping one bolt. The taper attachment does not involve the use of any extra working joints, the construction being such that the working joint of the cross-slide answers for both functions. Although the machine is nominally rated as of 14" capacity, its actual capacity is 15⅞". The tail-stock is of the English form which allows the setting of the compound rest parallel with the ways without interference on short work. The lathe is furnished either with or without compound rest or the taper attachment. The usual equipment of wrenches, face-plates, change gears, steady and follow-rests, etc., is provided. This lathe is built and sold by the Pratt & Whitney Co., Hartford, Conn., or 123 Liberty street, New York.

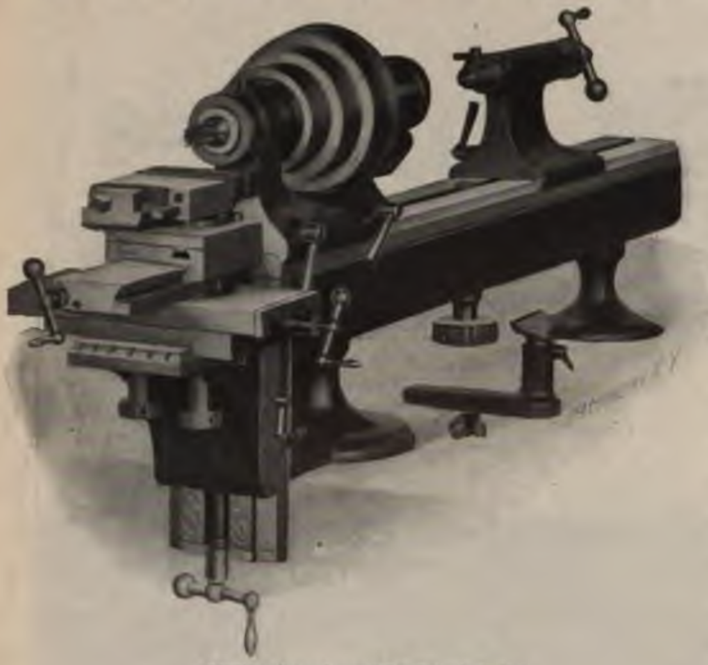
### A BENCH LATHE AND MILLING MACHINE.

The accompanying engravings show the Waltham Watch Tool, Co.'s No. 5 bench lathe arranged for turning and also for milling. The success of the No. 1 universal lathe has induced the company to meet the demand for a larger bench lathe made on the same lines and also provided with the Van Norman milling attachment.

The lathe illustrated has a 38" bed and 9" swing. The spindle is accurately made, being hardened and ground, and is made hollow throughout for the use of draw chucks. The chucks used on this lathe are made interchangeable with those for the Van Norman duplex milling machine. A full line of attachments is provided, so that screw-cutting, grinding, drilling, milling, etc., can be done, thus making a combination machine of wide application. The screw-cutting attachment has a capacity of 6" and a screw of this length can be cut at any point along the bed within the extreme capacity of the centers.


Nine-inch Bench Lathe.

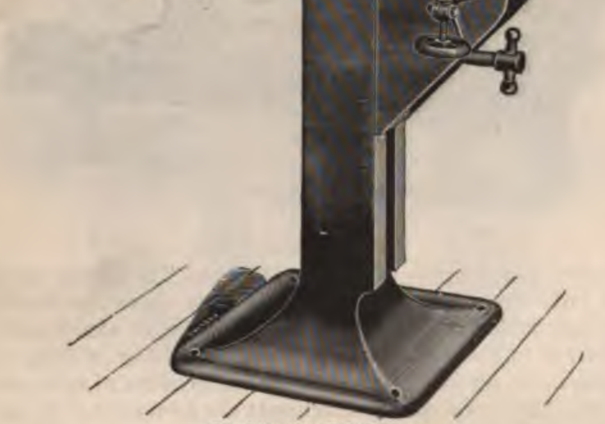
To use the milling attachment it is necessary to reverse the head-stock, which can be done very quickly. An upright angle slide is bolted to the vertical web, shown at the end of the frame, and the slide-rest is fastened on top, either in the position shown or turned around so that the cross-slide handle will come on the back. The slide-rest can also be mounted from the end, thus giving it three distinct positions. It will be noted that the slide-rest is so made that the addition of the swivel base milling vise completes the milling attachment. For index milling an index head is provided with a hollow spindle adapted to take in the regular split chucks used in the spindle. The vertical movement of the knee is 6", which, together with the 6" movement of the slides, gives the machine a considerable capacity and well adapts it to a large variety of model work, tool making, experimental and precision work of all kinds. It is manufactured by the Waltham Watch Tool Co., Springfield, Mass.



Milling Attachment for 9-inch Lathe.

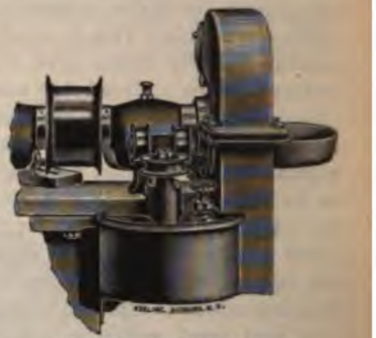
### TOOL AND SURFACE GRINDER.

The illustration shows a simple and complete water tool grinder and dry tool and surface grinder in one machine, having a number of distinct advantages. The wheels carried are 14" x 2", the intention being to provide a machine suitable for general use in the ordinary machine shop. The weight of the machine (650 lbs. with counter-shaft) and the diameter and length of the bearings, together with their self-lubricating properties, insure rigidity and steadiness of the entire machine and dispose effectually of the usual argument against a tool carrying two wheels.



Combination Grinder.

The arrangement of the water-pan and water-feed is such as to prevent spattering and to do away entirely with disagreeable features of the ordinary wet grinder. The operator has no pedal on which he must stand while at work, but is free to move about the wheel as he pleases. There is no rack, pinion, float, or other device for controlling or feeding the water, and it is utterly impossible for the wheel to stand in water to soften and spoil when not in use. The ordinary objections to a pump on a grinding machine do not apply to this tool, as the wearing surfaces of the pump bearings are at all times entirely above water. The unsightly pipe and valve which appear on many grinders directly over the wheel are entirely done away with in this machine, and the construction is such that the entire water-pan and water-way are easily and perfectly accessible when it becomes necessary to clean out the sediment.



View Showing Water Pump.

The importance of a surface grinder is growing in recognition in machine shops, and the arrangement of this machine is such that all ordinary surfacing work can be readily performed without interfering in any way with the water wheel.

The makers call special attention to the spindle and spindle bearings in this tool. The actual diameter of spindles in bearings is 1½" and each bearing is 6" in length.

Each bearing is provided with a sleeve of the best babbitt metal, this sleeve being bored, reamed and turned, and threaded on each end, the threads being right and left hand. The sleeves are held in place by a hollow nut on each end, and inside of each nut is a felt washer. The sleeves are slotted their entire length to provide for adjustment and to receive the oil, which feeds through a dust-proof cup on top of the box

Fay & Bowen, Auburn, N. Y., are the manufacturers.

* * *

## FRESH FROM THE PRESS.

Dynamometers and the Measurement of Power, by J. J. Flather, Professor of Mechanical Engineering, University of Minnesota. Published by John Wiley & Sons, New York. 394 12mo pages and 115 engravings. Price, $3.00.

This work is a treatise on the construction of dynamometers with a description of their application and also of the apparatus used in connection for the measurement of power. It will be of value to those having to do with the measurement of power whether they be experts or tyros in the business, as the matter is compiled from the author's own extensive experience and also from that of others who have had trustworthy experience with the subject. Considerable reference is made throughout the work to the Flather transmission dynamometer, which instrument is the author's invention, and to the valuable results obtained by its use.

The chapter on the power required to drive machinery and machine tools is peculiarly acceptable at this time when the use of the electric motor is becoming so extensive for isolated driving. The trustworthy information on the subject has generally been in a rather confused state, but in this book there appear a large number of tabulated tests which give opportunity for comparison by which, presumably, safe deductions may be made for shop installations.

Hydraulic Power Engineering, by G. Croyden Marks. Published by D. Van Nostrand & Co., New York. 360 8vo pages and 201 illustrations. Price $3.50.

This important subject appears to have been well handled by the author, as the work contains a wealth of valuable and interesting information. The first chapters are given to principles of hydraulics and the observed flow of water, with notes on the loss of head resulting from the contraction or bends in pipes. While this matter is more or less trite, it is presented in an attractive manner, and is, of course, necessary for proper introduction to the work. The practical matter on packings for sliding surfaces and pipe joints is of value. Lifting machinery receives considerable attention, one part of the work being devoted to platform lifts, workshop and foundry cranes, hydraulic accumulators, etc.

MACHINERY.

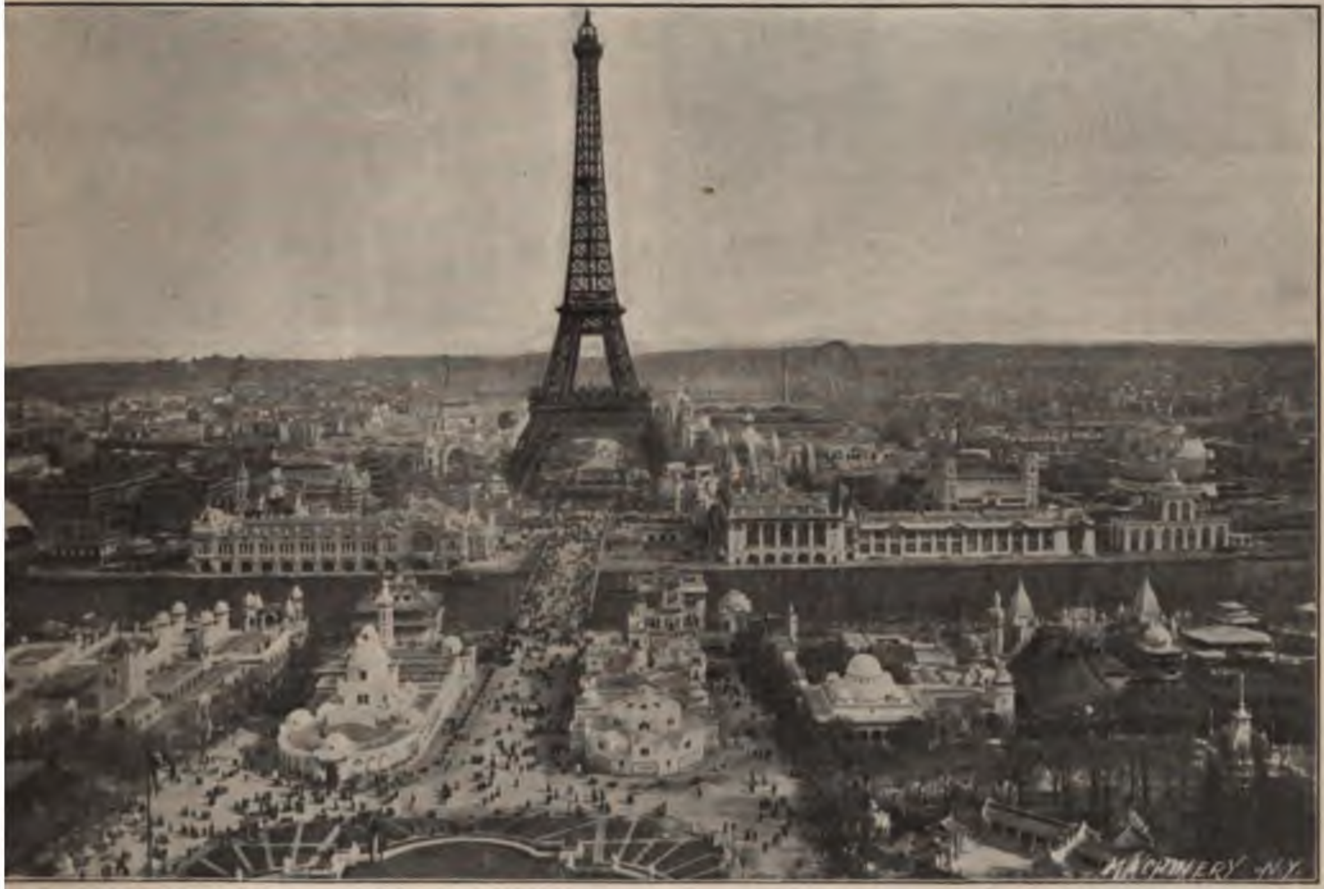
l. 6. June, 1900. No. 10.

# THE PARIS EXPOSITION OF 1900.

## A DESCRIPTION OF SOME OF ITS GENERAL FEATURES.

ANDREW D. FULLER.

he beautiful Salle des Fêtes, April 14th, 1900, France its fifth international exposition held at Paris since 1850. the past six years the work had been pushed steadily until a few days before the opening, when by an extra nd the help of the military forces, most of the perquisites struction were made to disappear, leaving the buildings ounds in all their attractiveness. The executive head of position has had the able assistance of M. Alfred Picard, mmissioner General, and the other members of the Ex- n Commission. At the beginning it was estimated that oject would cost about 100,000,000 francs ($20,000,000). overnment appropriated 20,000,000 francs, and the Munici- of Paris agreed to contribute a like sum on condition that xposition would be held within the city limits. The re- ng 60,000,000 francs were raised by an issue of 3,500,000 de l'Exposition, backed by a combination of the solid h banking houses. Every bond bears twenty admission of a face value of one franc each. The holder is also en- to a chance in a series of quarterly lottery drawings, a erable reduction in transportation on the French railways wenty-five per cent. discount on admission charged by the s attractions authorized within the grounds. Of the ,000 francs raised in this manner, 5,000,000 was estimated cost of printing, advertising, etc., in connection with the issue. It is estimated that the income from the various sions granted for amusements, restaurants, tobacco, news, stands, etc., will leave a profit of about 10,000,000 francs at the close of the Exposition, November 5th. As no tickets are sold at the gates, one must purchase them in the shops or from the venders who swarm about each entrance. It is forbidden to sell them for more than one franc. The immense number issued (65,000,000) makes it possible to get tickets for about one-half a franc or ten cents. From 8 to 10 in the morning and 6 to 10 in the evening two tickets are demanded.



. 1. General View of the Exposition. In the foreground is a section of the Trocadero Gardens, where are located the buildings of the foreign colonies. g the river Seine, in the foreground, is the Jena Bridge. Beyond the Eiffel Tower is the Champ de Mars, at the extreme further end of which is the f Electricity, where most of the machinery exhibits are placed. A plan of the Champ de Mars is shown on page 292.

The exposition proper, covering about 270 acres in the heart of the city, is divided into two principal sections, viz.: the Champ de Mars and Trocadero Palace and Gardens and the Esplanade des Invalides which is connected with the large area between the Champs-Elysées—formerly the site of the Palais de l'Industrie—by the handsome new bridge named in honor of Alexander III. of Russia. These two divisions are joined by the picturesque buildings and grounds reared on either side of the Seine, together with several new foot bridges erected for the occasion. Nearly one-half of the whole area has been built upon. In addition to this area there is at Vincennes, not far without the fortifications which encircle the city, an annex of some 275 acres, about six miles from the main buildings, where the races and athletic contests will be held. There also are found interesting transportation and machinery exhibits. Of the buildings used in former expositions, the Trocadero Palais, the Tour Eiffel and the Palais des Machines now renovated for the display of Agriculture and Food Products on either side of the Salle des Fêtes, in which all ceremonies are intended to take place, are the only ones retained. The Grand and the Petit

Palais des Beaux Arts, constructed near the Champs-Elysées in place of the Palais de l'Industrie, will be a worthy monument to the Exposition of 1900.

The exhibits are divided into eighteen general groups as follows: 1, Education and Instruction; 2, Works of Art; 3, Literature, Science and Art appliances and processes; 4, Mechanical Engineering; 5, Electricity; 6, Civil Engineering and Transportation; 7, Agriculture; 8, Horticulture and Arboriculture; 9, Forestry, Sport, Fishing, Wild Crops; 10, Food Products; 11, Mining, Metallurgy; 12, Decoration and Furniture of Public Buildings and of Dwelling Houses; 13, Thread, Yarns, Textile Fabrics, Clothing; 14, Chemical Industries; 15, Various Industries; 16, Social Economy, Hygiene, Public Charitable Relief; 17, Colonization; 18, Army and Navy. In devising the 121 classes which make up these groups it has been intended to have the exhibits follow in logical sequence, the products of all countries being displayed in such proximity that comparisons are easily made. This arrangement will be appreciated by those who visit the Exposition with instructive motives, and will be of unrealized benefit to those who seek amusement rather than education. Each group has a building and often a small annex in the immediate neighborhood. The buildings in the Champ de Mars are joined to make one grand building about the three sides of the tastily arranged central garden. At the open end stands the Tour Eiffel erected to a height of 300 meters at a cost of one million dollars.

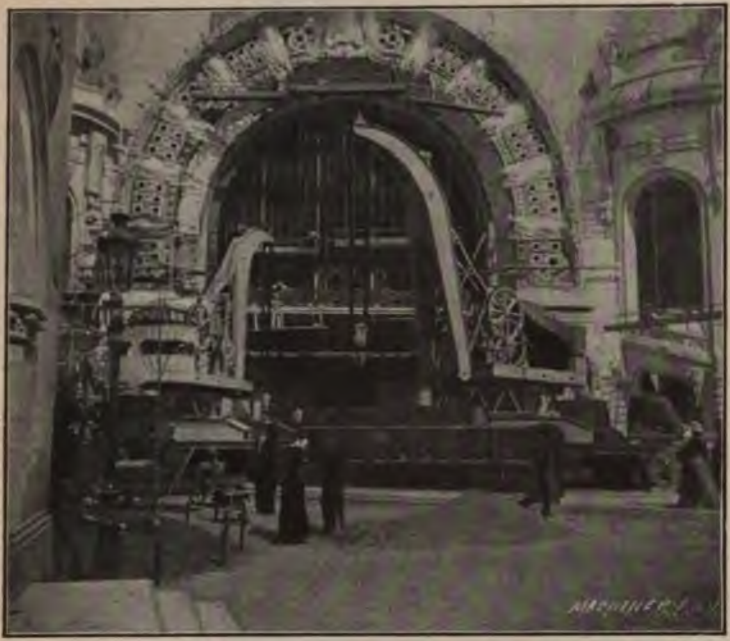


**Fig. 2. Entrance to the Palace of Mines, showing two Grue Electric Cranes for handling heavy mining exhibits. Twenty-five tons capacity.**

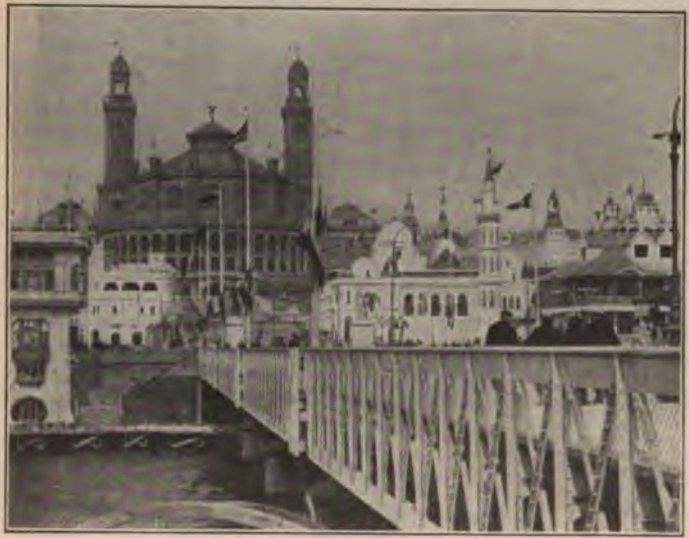


**Fig. 3. Jena Bridge over the Seine, looking towards Trocadero Palace.**

Mechanical Engineering, Electricity, Civil Engineering, Transportation, Mining and Metallurgy, the groups of especial interest to readers of MACHINERY, are all located in the Champ de Mars. The Palais de l'Electricite extends the entire width of the Champ de Mars forming the background for the Château d'Eau, a grand waterfall from which about a million and a half gallons of water per hour fall one hundred feet toward the broad basin below. The weird effect produced on the water by many colored electric lights is one of the evening features. Both ends of the electricity building are occupied by the huge power machines of different countries and a multitude of machines exemplifying the mechanical industries. An interesting portion of the Civil Engineering and Transportation Building is the artistic frieze, depicting transportation from the most ancient times to the present, adorning the length of its facade. International expositions have now grown so large that weeks are necessary to thoroughly inspect the exhibits of even a few selected groups. Easy access is had between the two principal sections by a circuit electric railway of the third rail type two miles in length, or by a moving platform which parallels the electric road and travels in the opposite direction at the rate of two and one-half miles an hour for the first platform and five miles an hour for the second.

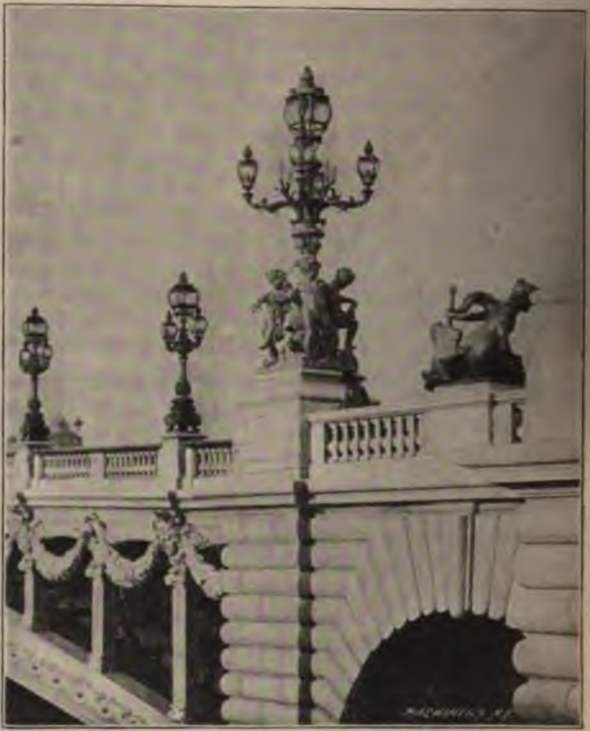


**Fig. 4. Bridge Alexander III. over the Seine, near the Palace of Fine Arts.**

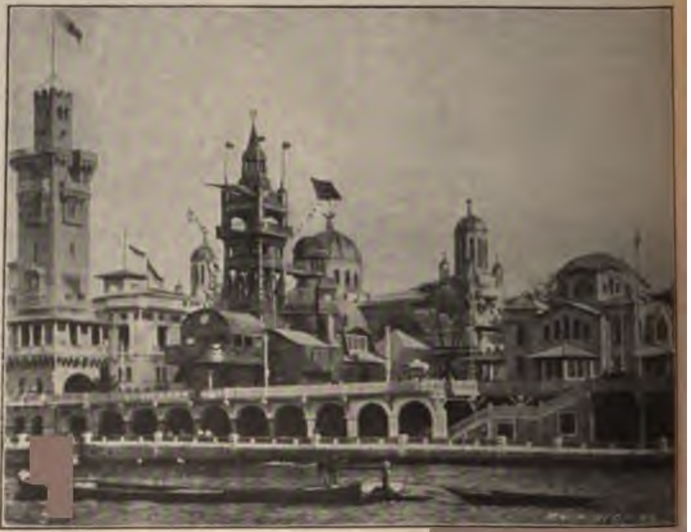


**Fig. 5. Buildings of Greece, Sweden and Monaco. Greece, low building at the right; Sweden in the center, and Monaco, at the left.**

The principal amusements are located along the Seine and in the Trocadero Gardens where the Colonial section exhibits all the picturesqueness of the life and habits of foreign lands.

The "Grand Palais" of Fine Arts. Fig. 7. Bridge Alexander III., with the "Petit Palais" in the distance. Fig. 8. The "Petit Palais" of Fine Arts situated opposite the "Grand Palais."

THREE ARTISTIC FEATURES OF THE EXPOSITION.

# MECHANICAL FEATURES OF THE EXPOSITION.

## THE EXHIBITS AT CHAMP DE MARS AND VINCENNES BUILDINGS.

WARREN E. WEINSHEIMER.

The principal portion of the Palace of Electricity, where are installed the large engines and dynamos, consists of a long, narrow strip, 400 x 50 meters, extending across the Champ de Mars, north of the Palace of Agriculture, which is at the extreme southern end of the Champ de Mars, and was used in the exposition of 1889 for the Machinery Hall. There is a space of 40 meters between these two buildings where are located the boilers. As will be seen by the plan, the Palace has two wings extending along the Champ de Mars on both ends. These wings are devoted to smaller machines, as tools, gas engines and general machinery.

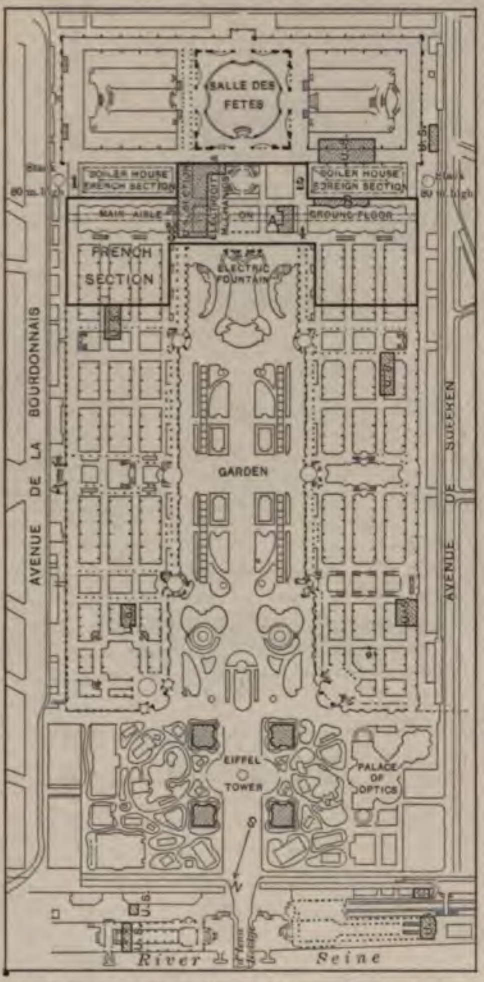


**Fig. 1.** Plan of the Champ de Mars where are located most of the Engineering Exhibits. The Palace of Electricity is at the upper end. The shaded portion of this building is the United States section, and is shown in Plan in Fig. 2.

The French have reserved the east wing and the corresponding portion of the building, about 40 per cent., for themselves, and the remaining 60 per cent. is divided proportionally among the foreign nations. The Main Palace has a gallery 14 meters wide running around the entire building with a broad transverse gallery in the middle called the Salon d'Honneur, where are located the retrospective exhibits. This leaves two large light wells at either end, making a fine place for the traveling cranes and large engines which extend above the level of the gallery.

Starting with the two boiler houses, indicated in Fig. 1 and one of which appears in Fig. 3, one observes that they are roofed structures of corrugated iron and skylight 120 x 32 meters long and 32 meters wide. There are two immense chimneys for the boilers, one at the outer end of each house. These chimneys are built of brick of various colors, making a beautifully ornamental effect. They are 80 meters high, 8 meters exterior diameter and 6 meters interior diameter. The chimney is connected with the boilers, which are arranged in two rows, by an underground flue running two meters underneath the 5 meter aisle between the rows of boilers. The fuel used is soft coal and is brought in on the track in the middle of this aisle. The front of the boilers where the firing is done presents an interesting view, there being a distance of 7.5 meters to the adjacent buildings from which to see them in operation, also the feed pumping devices. The steam from these boilers are taken to two large headers and from there are distributed to the different engines through underground tunnels. In back of these two headers, which are located on the 7.5 meter aisle facing the Electricity building, are two large stacks two meters square and extending to the top of the boiler house roof, for taking away any escaping steam in the tunnels and also ventilating the same. Steam is furnished at 100 pounds pressure, and, with the 50 boilers, represent about 15,000 H. P., or for both boiler houses, a total of 30,000 H. P.

In the French section boiler house are six boilers of Rosior, of St. Denis, Seine. Next to these are three from Compagnie De Fives, of Lille. Then there follow 6 from A. Montupet, of Paris; 1 from Solignac, Grille & Cie, Paris; 1 from Bietrix, Leflaive, Nicolet & Cie, of St. Etienne, and to finish the row on the right are 6 from De Maeyer & Cie, of Proung. On the other side is a large battery of 16 from Babcock & Wilcox, showing their different types, and finally 12 boilers from J. & A. Niclausse, of Paris. All these boilers, with the exception of the Babcock & Wilcox, are down-draft return tubular boilers.

Entering the Palace of Electricity one should first mount the grand staircase for a bird's-eye view. The most prominent features are the two immense cranes seen in Figs. 4 and 5. Fig. 4 shows the cantilever crane in the French section running on tooth tracks placed on either side of the main aisle. This crane was built by Jules Le Blanc, of Paris, and is arranged to revolve on a circular track on top of pedestal. The engines are all direct-connected to generators and vary from 2,000 to 5,000 H. P.

Fig. 5 shows the foreign section with the large truss crane built by Carl Flohr, of Berlin, Germany. This view is also looking from the top of the grand stairway and other end of Salon d'Honneur. The first section on the right in the picture belongs to Belgium, the one on the left to Great Britain and the whole space on either side of the aisle at the end of the building is given to Germany. This section will probably be the most interesting to the average visitor, as it con-

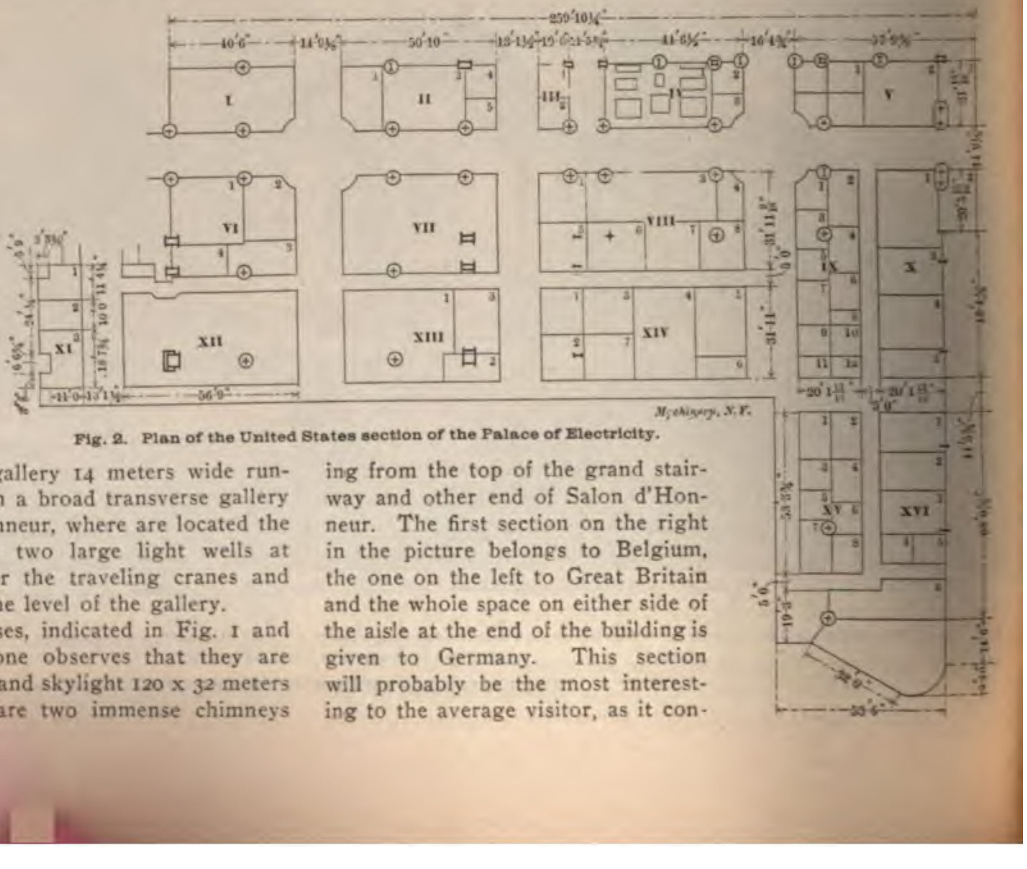


**Fig. 2.** Plan of the United States section of the Palace of Electricity.

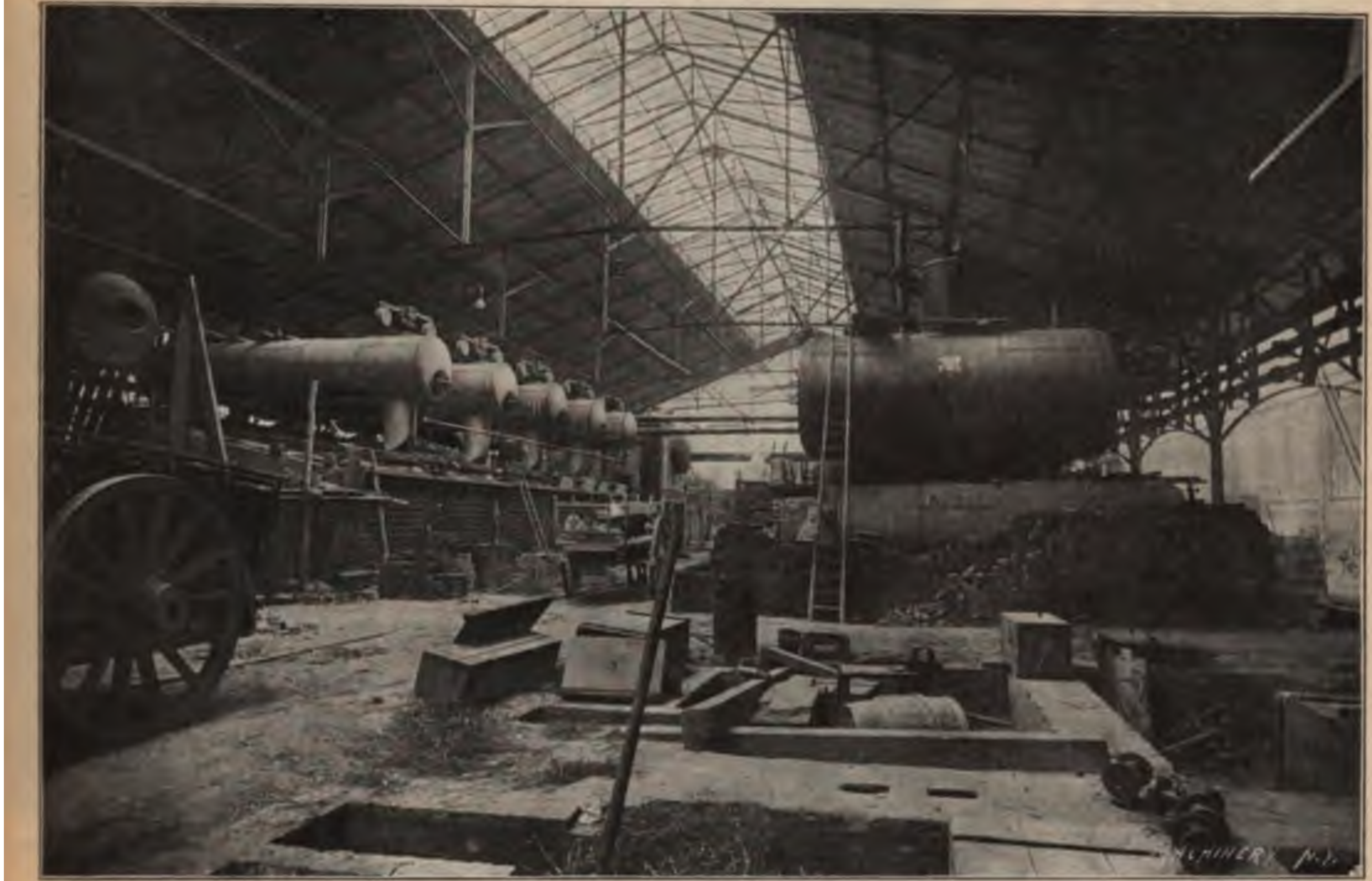


Fig. 3. Interior View of the Foreign Section Boiler House of the Palace of Electricity, looking from Point 2 in the plan. There is another boiler house of the same size and construction devoted to French boilers.

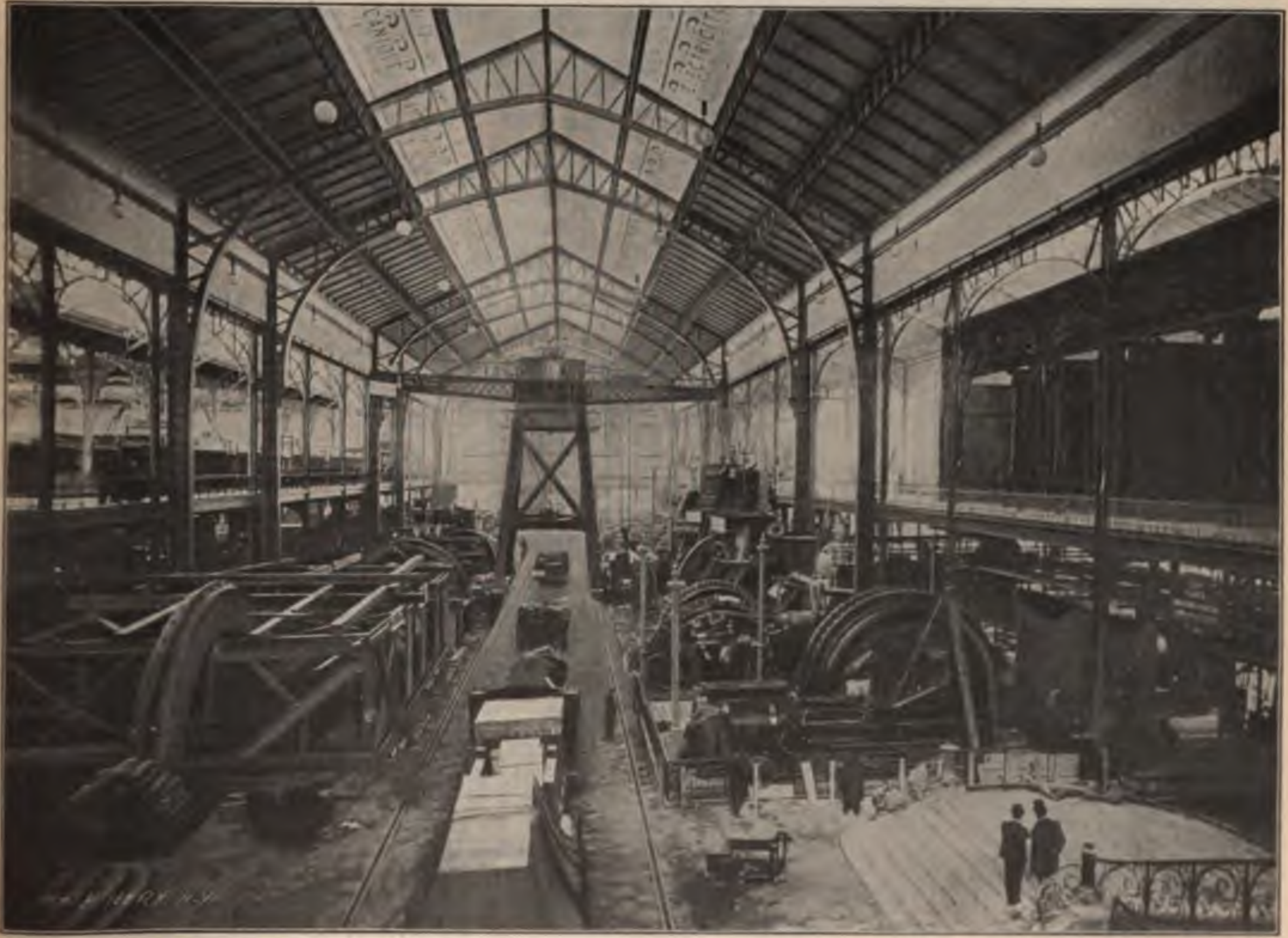


Fig. 4. Interior of the Palace of Electricity, looking from Point 3 in the plan. The Cantilever Traveling Crane is of French manufacture.

tains the largest engines, a closer view of which is shown in Fig. 6. The engine on the left, Fig. 6, is from Vereimgte, Maschinenfabric, Augsburg, and Maschinenbangesellschaft, of Nuremberg, direct-connected to a generator of Helios Elektricitats of Kohn, and is a four-cylinder compound engine of 6,000 H. P. Next to this is a 1,500 H. P. two-cylinder compound vertical engine from Lahmeyer & Co., from Frankfurt-on-Main. The engine on the right in the corner is a 5,000 H. P. three-cylinder triple expansion marine engine from Schuckert & Co., Nuremberg. The next is a 2,500 H. P. triple expansion engine from A. Borsig, of Berlin, connected to a Siemens & Halske generator.

As will be seen by the photographs, the gallery is used for installing the small apparatus and devices of machinery and electricity. Fig. 6 shows a fine exhibit from Schaffer & Budenberg, of gages, calorimeters, etc., and from Siemens & Halske, of electrical apparatus. The larger machine tools, such as lathes, planers and drilling machines are on the ground floor. Fig. 5 shows a fine exhibit of this from Chemnitz, also general machinery, as shafting, pulleys, etc., from Maschinenban, Act, Ges Dessan, Berlin. J. E. Reinecker has a large exhibit of lathes, etc.

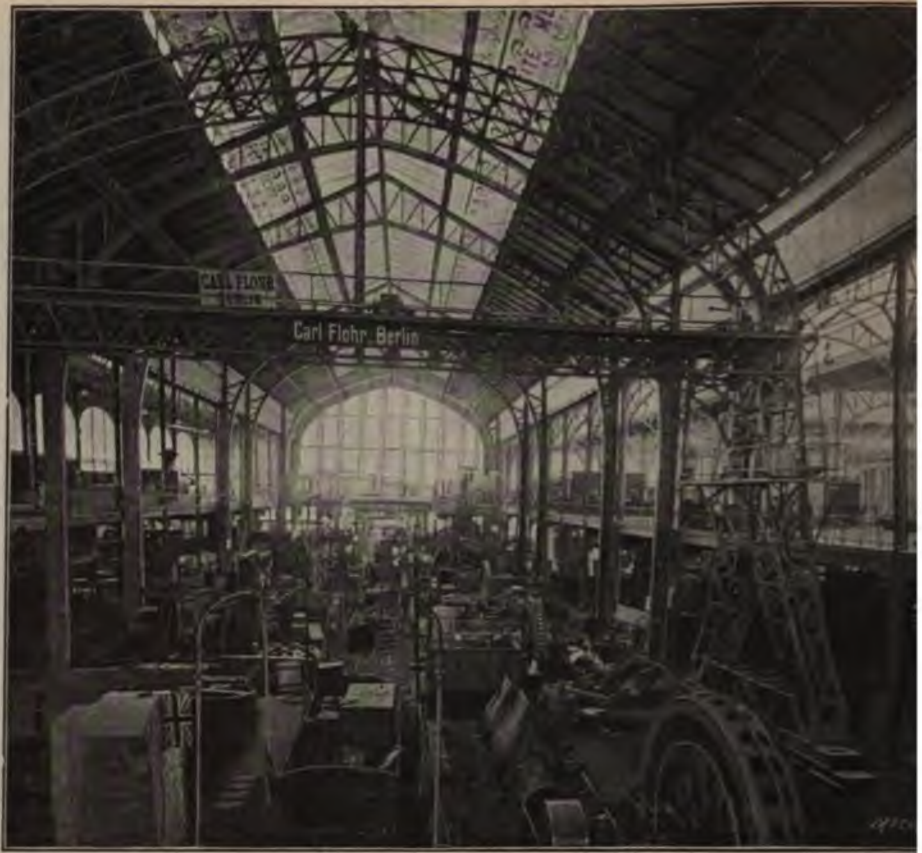


Fig. 5. Interior of Palace of Electricity viewed from the end opposite to that in Fig. 4, or from Point 4
A German Traveling Crane appears in the Foreground.

In the English section there are two engines, one from & Co., Limited, and a triple expansion engine from Wi Robinson, of Rugby, England.

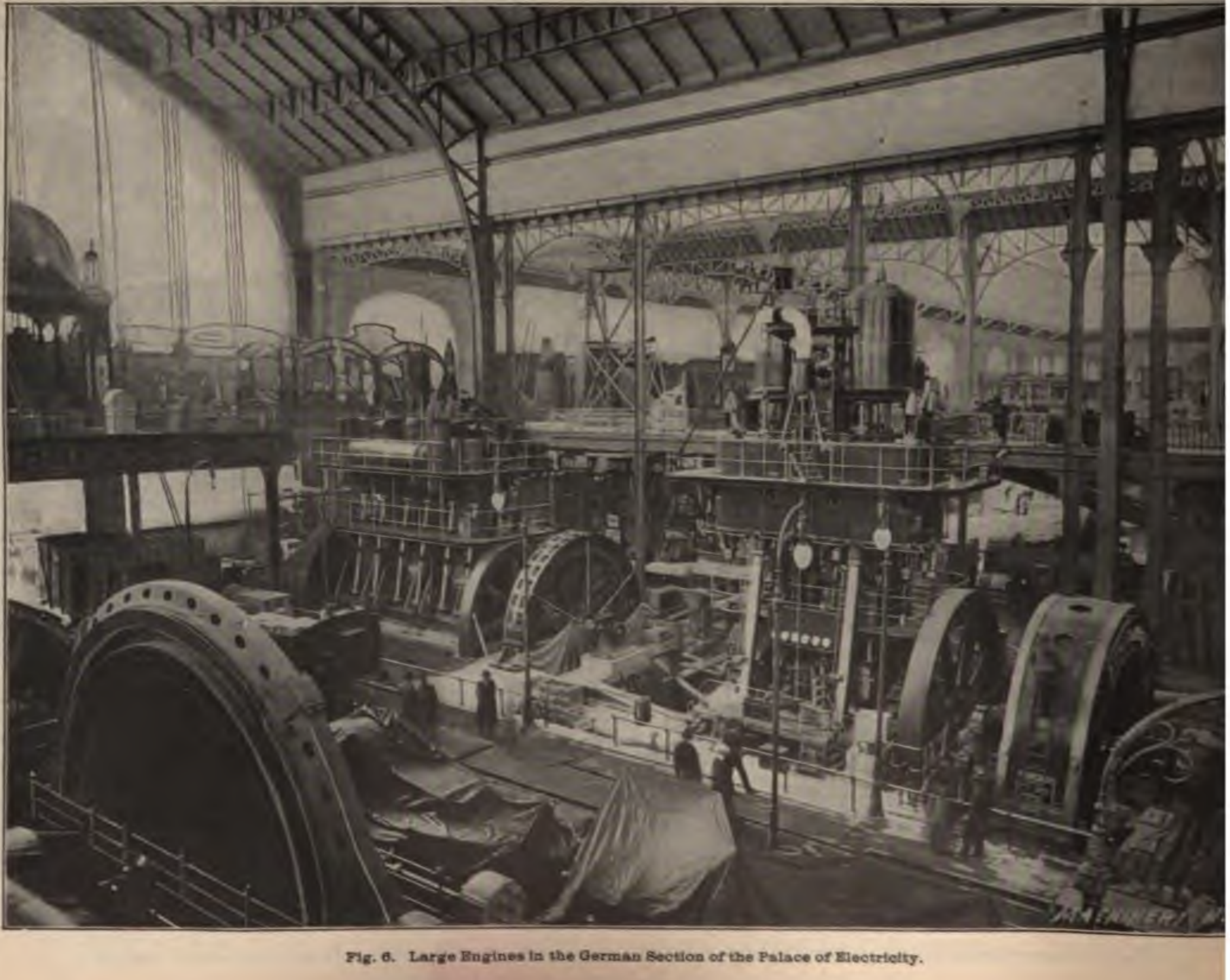


Fig. 6. Large Engines in the German Section of the Palace of Electricity.

The Belgian section has a very interesting engine, two-cylinder compound, 3,000 H. P., from Carles Freres, of Ghent.

### UNITED STATES MACHINERY BUILDING AT VINCENNES.

The United States Machinery Building was designed with the idea to represent a model American machine shop where the visitors could see every variety of American machine tools in operation. Fig. 7 shows the front elevation of this building, which is composed of a main building 350 feet long, and 76 feet wide, and an annex 225 feet long and 48 feet wide. The framework is constructed of steel from the Carnegie Works and was erected by the Berlin Iron Bridge Co., in eight days and by 14 American workmen. In addition to the machine tools, this building contains in the annex the cotton gins, a large cotton compress machine and mining machinery such as air compressors, rock drills, etc.

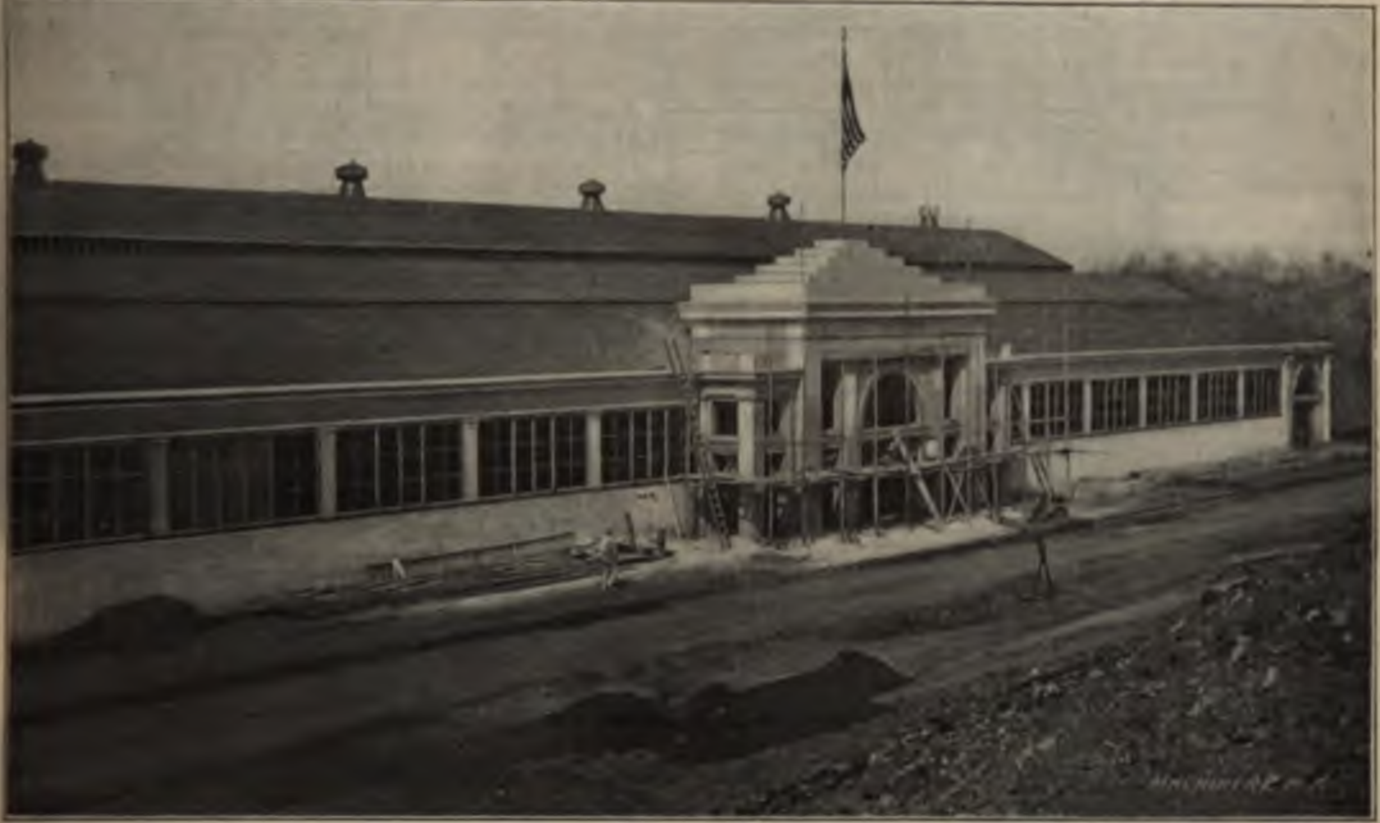


Fig. 7. United States Machinery Building at Vincennes---The American Machine Shop equipped throughout with American Tools.

Power is furnished by two 250 H. P. Morrin Climax boilers which are fed by a Blake pump and Lee injector, the piping being so arranged that either pump or injector may be used and the supply taken from cold water mains or hot well, also through or around the exhaust steam feed water heater.

The steam engine plant consists of a 300 H. P. tandem compound Ball engine, direct-connected to a 200 K. W. 220 V. compound-wound multipolar Bullock Electric Co. generator. This furnishes current for the motors of the various exhibitors and also for the 30-ton Shaw electric crane. Three weeks before the opening of the Exposition, the Pauillac with engine crankshaft and generator on board was given up as lost. A temporary engine and dynamo were ordered from the Westinghouse Co. of Havre, and this was put in place and was the only engine that ran on the opening day.

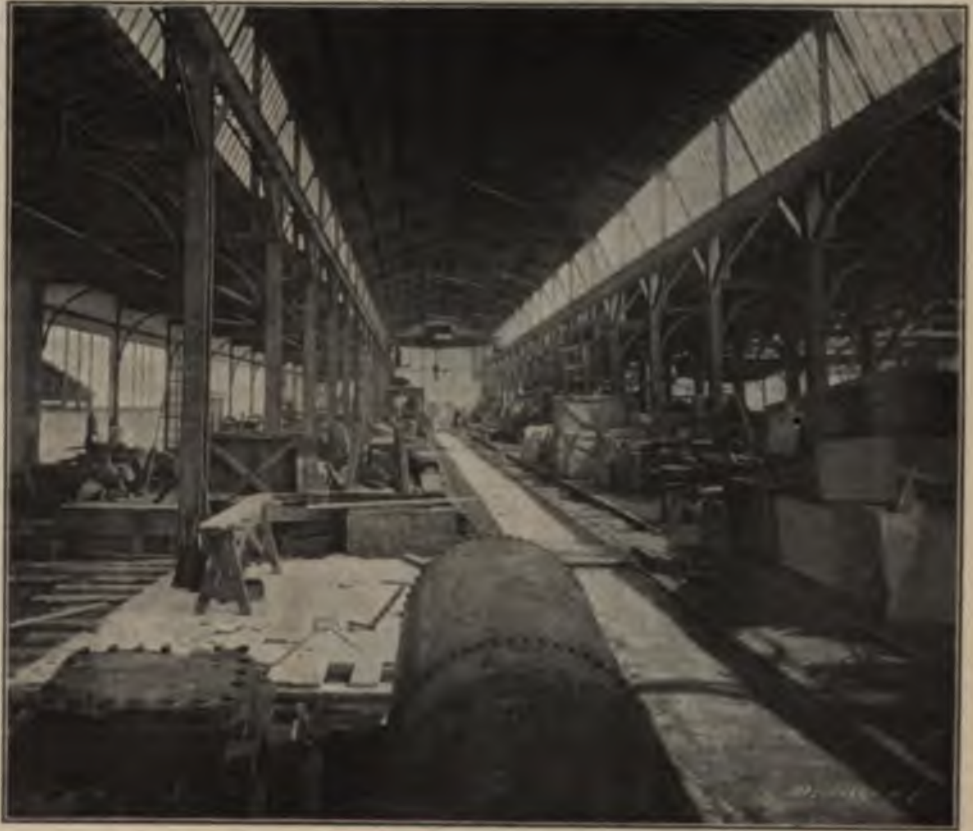


Fig. 8. Interior of Vincennes Building during the Installation of the Machinery.

The temporary engine is a four-cylinder 200 H. P. vertical Willans type, connected to a 150 K. W. 220 volts bipolar shunt-wound Crampton dynamo. Besides this engine there are three large air compressors supplying 2,500 feet of air per minute at 150 pounds pressure, running 15 exhibits, including pneumatic tools and small steam engines required to exhaust into the shop, also all the air for the locomotives for the English and American sections.

Electrical transmission is adopted throughout the shop and wiring is carried out according to a most approved method of shop wiring. The unloading of cars was taken care of by the

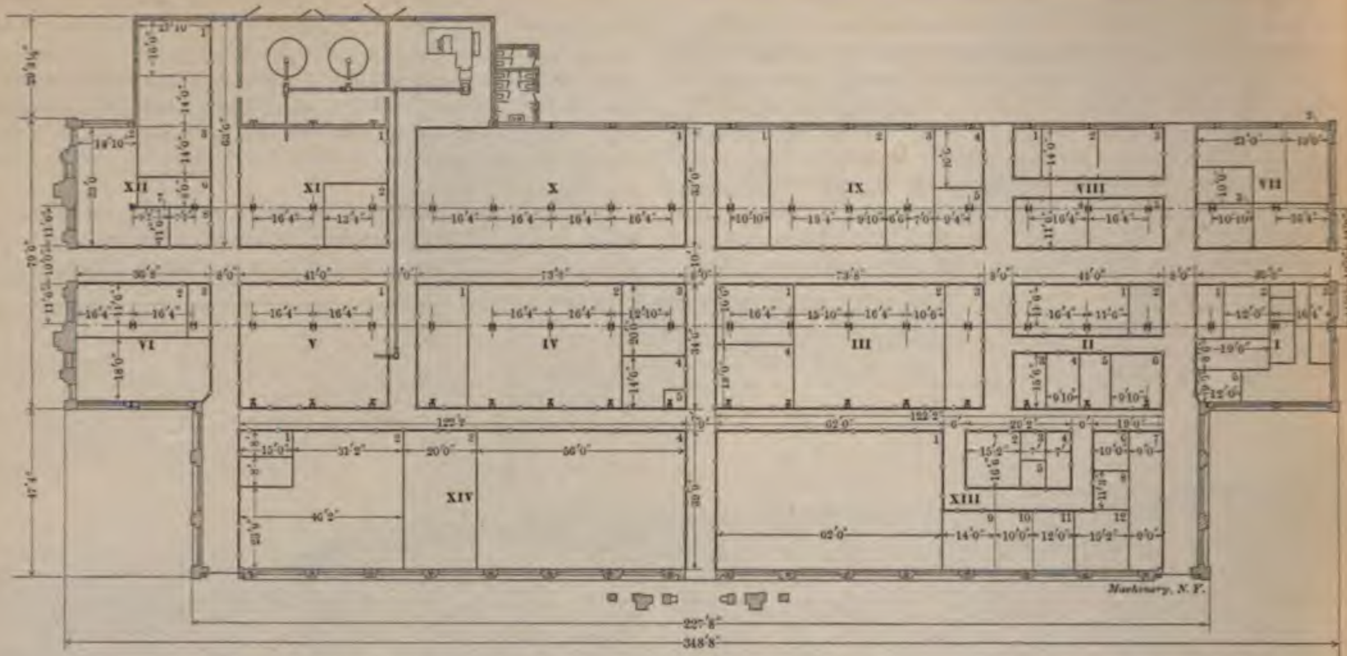


Fig. 9. Plan of the American Machinery Exhibit at Vincennes. The reference numbers of this cut and of the one shown on page 292 will enable one to find the locations of the various exhibits referred to in the Supplement.

electric crane. The charge being actual cost by the ton hour. This figure was computed from data taken for 15 days, including total ton hour service for each exhibitor and all expense and cost for power.

* * *

## HAND AND POWER FEED MILLING MACHINE.

The illustration shows the Fox No. 3 hand and power milling machine which is a tool specially designed for light and medium manufacturing. It has the advantages of the hand feed milling machine together with that of the power feed machine, as it possesses a hand rack feed, a hand screw feed and a power screw feed. The feed can be started or stopped while the machine is in operation or can be reversed by slightly turning the star wheel shown in front of the hand-wheel. As will be understood the combination of hand and power feeds gives the advantage of a quick return to the platen when the feed is disengaged, as the platen is returned by one movement of the hand lever. The knee and saddle are counterbalanced by a weight inside of the column so that a free and easy action is obtained for hand feeding.

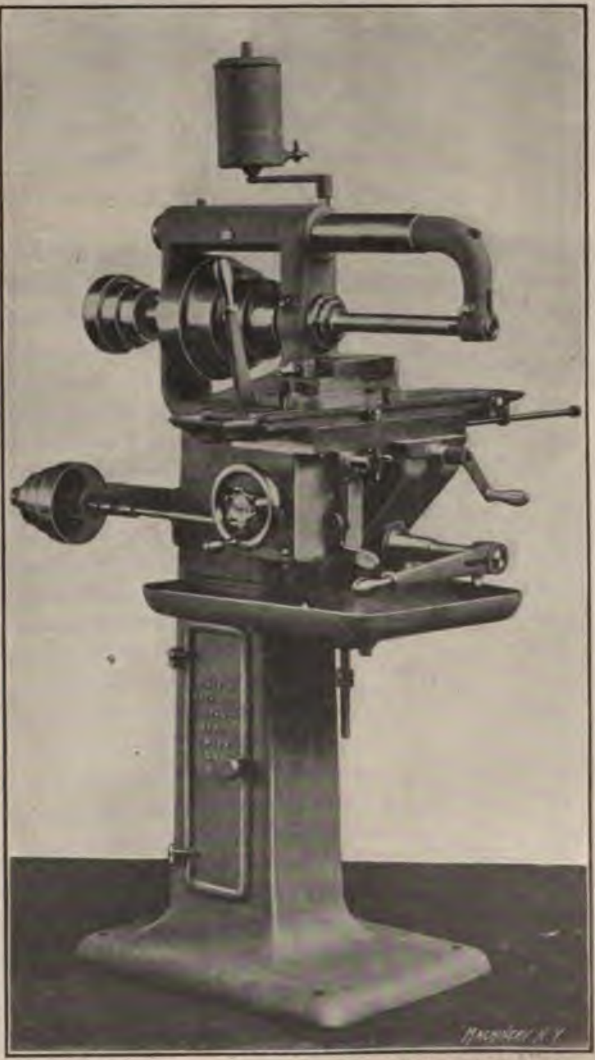


Fig. 1. The Fox Hand and Power Feed Milling Machine.

The spindle boxes are made of bronze boxes which have a form of adjustment that allows the wear to be compensated both horizontally and vertically. This is effected, as shown in Fig. 2, which shows the box divided into three parts and the upper sections provided with set screws for taking up the wear. The spindle is bored for Brown & Sharpe No. 9 taper. The distance between the spindle center and the overhanging arm is 4½". The platen is 6" x 24" and has a longitudinal movement of 17¼".

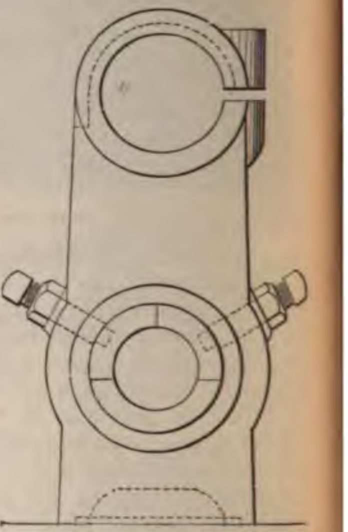


Fig. 2. Details of Spindle Boxes.

The weight of the machine complete with a two-speed countershaft is about 640 pounds. It is manufactured by the Fox Machine Co., Grand Rapids, Mich.

* * *

### SHOULD HAVE BEEN A POET.

A reporter in describing a new Western shop recently, said: "One of the new machines is a twelve-foot open-side Detrick & Harvey iron planer. It weighs 13,500 pounds and is so arranged that it can plane a piece of iron on the top and on the side at one and the same time. It works with the utmost regularity, planing off thick iron shavings as easily as a carpenter's plane turns up the curling pine shavings that little children love to wear in imitation of an old maid's curls."

This is quite sentimental, if true; but hardly less so than his description of the foundry, where the molten iron reminded him of the "red cranberry sauce that grandmother used to pour out into molds to harden."

* * *

One boiler horse-power equals 34.5 pounds of water evaporated from and at 212 degrees per hour.

## ABSTRACTS OF PAPERS

### PRESENTED AT THE CINCINNATI MEETING OF THE A. S. M. E.

Because of its timeliness, perhaps the "star paper" of the session is that by Mr. Arthur Herschmann upon the automobile wagon for heavy duty. Mr. Herschmann is the mechanical engineer for the Adams Express Company, New York, and has been on an extended trip through Europe studying the automobile problem for his company. The result is the steam wagon for heavy duty that he has designed and to which much of the paper is devoted. As the paper will be of interest to the majority of our readers, copious extracts are made from it in what follows.

### THE AUTOMOBILE WAGON FOR HEAVY DUTY.

Taking up the different propelling agencies which have been experimented with so far, we find that almost every known motive power has been tried. Steam was employed as early as 1820, and such wagons were built by the world-renowned Ericsson and Tangyes in England, and even James Watt is said to have constructed a steam carriage.

Naturally, in this country, leading the world in electrical subjects, expectations were greatest with electric vehicles. The electric equipment renders a vehicle clean and easy to operate. These vehicles can be made to answer the requirements of running on smooth city roads. The suitable commutation of battery cells provided in these vehicles, effected through interconnection of contacts on the "controller" affords, together with the series and multiple arrangement of the motor, some flexibility in the power and speed conditions of the machine. There are, however, inherent disadvantages to the use of batteries, which grow prohibitive in a motor wagon intended to carry heavy weights over a long distance. It is common experience that on rough roads the punishment is more than the batteries can stand, and where we have a case of heavy loads to be carried, necessitating the use of steel tires, we can well say that at this phase of the evolution the battery makes the electric truck an impossibility. The "maintenance" of batteries, apart from the actual cost of charging, is seldom spoken of, though it is perhaps the most serious item.

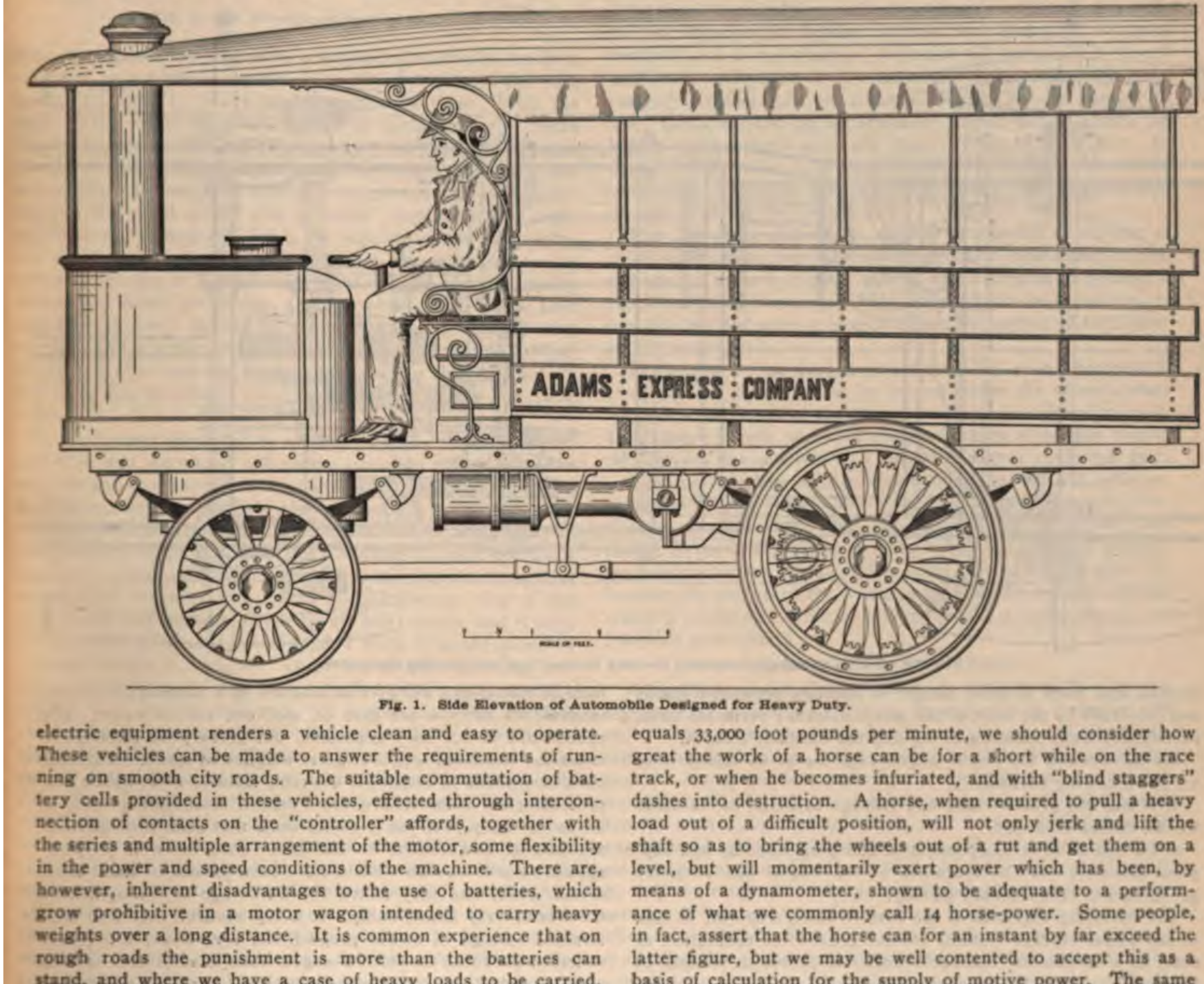


Fig. 1. Side Elevation of Automobile Designed for Heavy Duty.

Next to the electric wagon we saw the auto-truck, or, better still, heard about it. It was stated that compressed air trucks would soon be operated in considerable numbers. Now, while it cannot be denied that compressed air would make an ideal motive power, we have still to look for a complete revolution in the construction of light storage tanks to render this power available for trucks, granting that other disadvantages inherent to the use of compressed air can be practically overcome. Weight for weight, stored electricity lends itself more readily to the propulsion of wagons, since it will, as it were, "keep pressure" until it becomes well nigh exhausted, while the air pressure falls gradually as the air is drawn from the storage tanks. The tank weight per cubic foot of air is about 85 pounds; the air itself weighs 11 pounds, and at 2,000 pounds per square inch, represents 0.27 horse-power hours. To heat the air, considerable weight has to be carried.

A great deal of experience has been gained with oil-motor wagons, though chiefly in the line of light pressure vehicles; and France, in which country there are many thousands of these vehicles plying, has led the world in their exploitation.

As regards freight vehicles, however, no important results have been obtained with the use of explosive motors. A motor wagon, on account of its great weight and peculiarity of operation, must have an abundant supply of power; so great, in fact, as to puzzle the uninitiated observer. We find that a load which can be easily negotiated by one horse, calls for a power equipment equal to about 14 horse-power on the part of a motor wagon. While we commonly understand that 1 horse-power equals 33,000 foot pounds per minute, we should consider how great the work of a horse can be for a short while on the race track, or when he becomes infuriated, and with "blind staggers" dashes into destruction. A horse, when required to pull a heavy load out of a difficult position, will not only jerk and lift the shaft so as to bring the wheels out of a rut and get them on a level, but will momentarily exert power which has been, by means of a dynamometer, shown to be adequate to a performance of what we commonly call 14 horse-power. Some people, in fact, assert that the horse can for an instant by far exceed the latter figure, but we may be well contented to accept this as a basis of calculation for the supply of motive power. The same horse having pulled his wagon out of the difficult position, is able to modify the output of his energy, propelling the wagon at a good rate of speed as soon as he reaches better ground. The "speed-changing device," which should as nearly as possible emulate the peculiarity of the horse's muscular system, is still the greatest problem with designers of oil wagons. An oil engine to run a motor wagon cannot be well designed to vary in speed, at least not in a wide range, and be satisfactory in other respects. Its construction necessitates its running at a constant speed, whilst the speed requirements of the wagon wheels, to which it is geared up, are ever changing. Clutch and shifting gear wheels are, therefore, essential parts of every oil-motor wagon, and their operation, on account of the impact of the moving masses, often gives rise to serious trouble. Non-reversible, an oil engine is by no means a flexible motor. It will not start under load, and when it is in running condition it is very dependent on an even influx of its explosive mixture, and is liable to come to a dead stop without warning when its capacity has been suddenly overtaxed. Anybody who may have gotten stuck with a motor vehicle while ascending an incline will appreciate these remarks. In such a case it will occur to him that it is very difficult at the same time to release the brake and start the wagon "ahead" on slow speed. It need hardly be said that an oil vehicle is dependent on the weather, inasmuch as the action of the carburator is influenced by the atmosphere. This latter idea leads to the subject of perfect or imperfect combustion and its attendant outward sign, which is an evil-smelling exhaust. The good behavior of large oil engines on heavy trucks after an extended period of running has not yet been satisfactorily proven, and the deterioration due to the pounding on the frame is a serious drawback. The general use and handling of large quantities of gasoline at this stage of evolution of the oil engine is by no means free from risk of explosion, and there is some danger of affecting perishable goods and foodstuffs by the odor, which would naturally permeate them, particularly while standing at the express company's depot.

We have found the steam wagon superior to its competitors for the following reasons:

1. It has the greatest load and mileage capacity, or, in other words, radius of action.

2. Its operation is independent of charging stations, and supplies necessary for the operation of the wagon can be easily procured and taken aboard quickly.

The operating expenses in the case of an electric (or, in fact, of any power storage system) vehicle, grow to be prohibitive as soon as a certain ton mileage capacity is exceeded, tending to keep such an electric wagon small in size.

In the case of an oil wagon such economic restrictions to the size do not exist, and the objections to an oil wagon of large capacity are more by virtue of difficulties in operation.

With steam the case is altogether different. The tendency is here, to build a large wagon, since with a steam wagon the weight of the machinery to be carried does not grow even in an arithmetical ratio to the carrying capacity. One advantage found in the operation of a large steam wagon may not be apparent to the casual observer. In the case of the horse-drawn wagon one has to discriminate in loading it with goods which are to be delivered only on the exact route covered by the wagon seeing that the daily carrying capacity of a horse is limited, while in the case of a large steam wagon this would be less important, since, as will be shown later, the percentage of operating expense due to the actual cost of propulsion proper is infinitely smaller than in the case of traction with animal power.

### Construction.

Easy riding wagons have been constructed for many years, and boilers, steam connections, and engines do not give much trouble on rock bottom foundations, but when we attempt to locate engine and boiler on a wagon, which latter they have to drive without suffering from the shock of the locomotion on rough roads, new complications arise which are infinitely more important and troublesome than most people believe who have devoted themselves to the study of this subject. We find early attempts to effect this compromise in a steam vehicle built by the Ericssons in England in 1830, who placed a vertical engine on the rear of their vehicle, and coupled it up with a long springy connecting-rod to the front wheels, which acted as drivers, thereby preventing excessive shock being transmitted from the wheels to the engine.

Wheels in themselves are far more important problems than is generally believed. My opinion is, that at the present day no form of rubber tire will give satisfaction on a commercial wagon intended to carry a net load of, say, one ton or more. The rubber tire is not only expensive, but gives poor satisfaction under the combined action of great weight and speed. Attempts have been made to retain the desirable features of a rubber tire, protecting the latter with a tire shield of steel, dating back as far as the early 70's, but it would seem that such combinations are just as troublesome to maintain. Steel tires, if properly applied to stiff wooden wheels, have been proven to stand most severe work, and they afford the advantage of strengthening the wheels very considerably. It is my opinion, that well constructed springs of ample proportions, are, alone, the means to lessen the shock to which a wagon wheel is subjected. In the case of dished or, cored wheels, which I consider to be best adapted for heavy work, a steel tire is indispensable, since it binds the wheel together and prevents the spokes from being torn out when striking an outer obstruction. There is considerable divergence of opinion as to whether a comparatively narrow tire or a wide tire should be used, whether the wheels should be small or large, and whether the front or hind wheels should be driven or steered. While it is a fact, even in the case of motor-propelled vehicles, that the width of the tires should be smaller on hard roads and greater on soft roads (but not on sandy roads or in snow), I think that in the case of steam

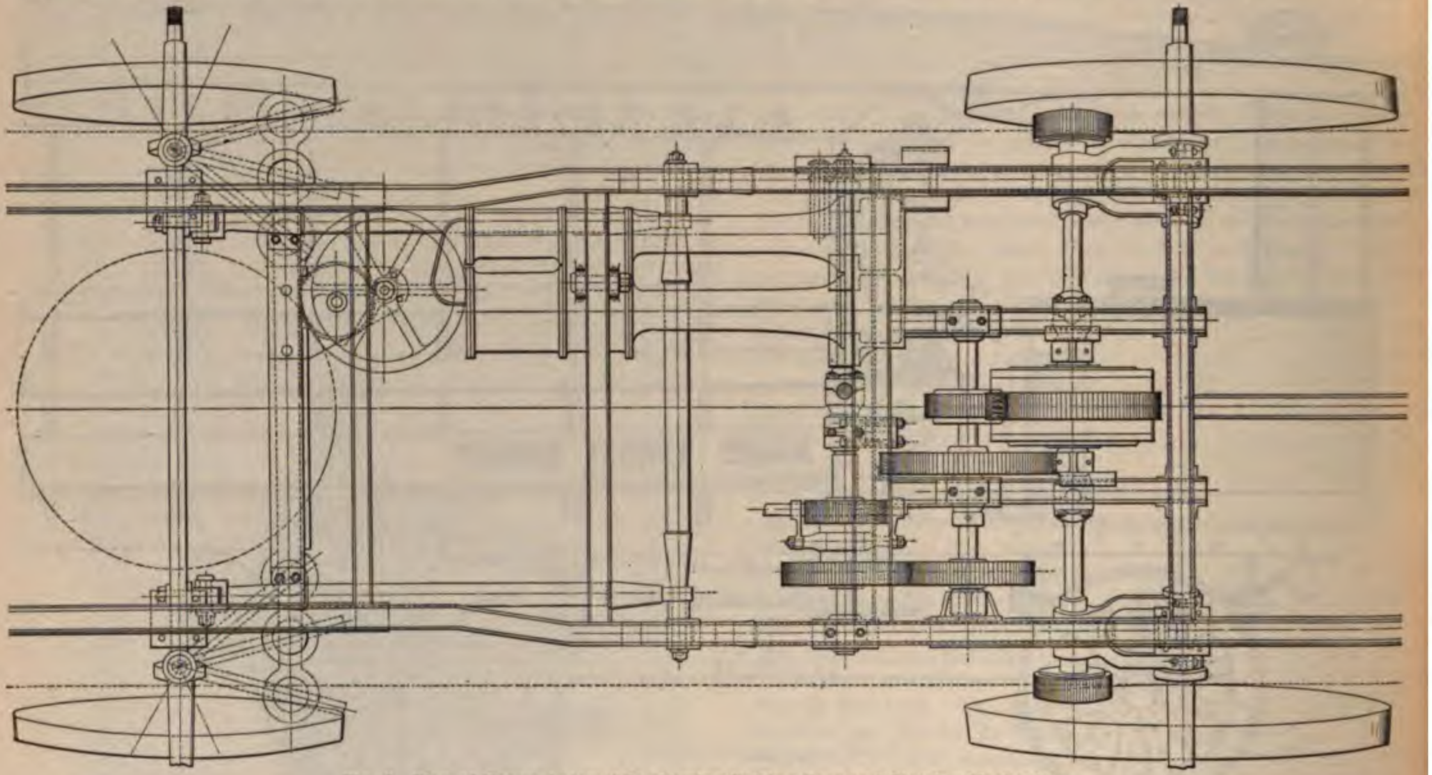


Fig 2. Plan of Heavy Automobile showing Driving Gear and Steering Mechanism.

ns the total width of the tires in inches should be at least the number of gross tons carried when small wagons are rrned, say of a capacity of two tons of net load; this coeffi- of two, to decrease, in the case of very heavy wagons, to nd even under.

e reason why small driving wheels seem to be exclusively on motor wagons are mostly that it is difficult to design wheels which will stand such severe strains as motor wagon ls are subjected to. In this case the spokes of the wheel nly support the load, as in a horse-drawn vehicle, but they ore or less affected by the action of the driving power, and, over, there is also a tendency to twist them. With the wagon wheel the power should be applied directly where heel touches the ground. In reality we drive onto a spur , or chain wheel, concentric with the wheel, but, of course, maller diameter, and such an arrangement makes it desira- at the wheel should also be small. Another reason mak- nall wheels desirable lies in the requirements of the wagon, he working of a high speed motor. In other respects it to me that a large driving wheel, say of 4-foot diameter, nswer much better than a 3-foot wheel, such as has been t exclusively applied to steam wagons. I consider that nly will a 4-foot allow of a more powerful starting torque, will also save the driving gear, seeing that it does not as deep as a small wheel when it passes over a depression road.

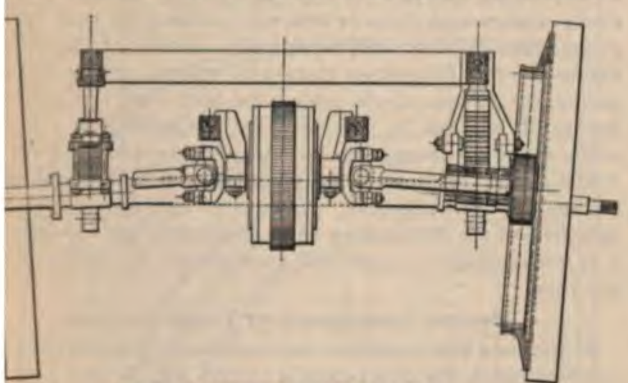


Fig. 3. End Elevation of Driving Gear.

argument presented by advocates of the "front driving" is, that the wagon will steer a straighter course when the strikes an obstruction, for the reason that the front wheels, king, tend to run over the obstruction, instead of being aside. I have seen such wagons steered behind and in and my opinion is, that any advantage of front driving is than outbalanced by the disadvantages introduced in con- with awkward location of the machinery. One of the steam wagons was driven by all four wheels, and if such could be practically effected, I think it would prove an nt feature of a wagon. There are, roughly speaking, two g systems used—steering with a fifth wheel, and, secondly, g with pivoted axle ends. It would seem that the fifth steering arrangement is more adapted for heavy work, the wagon axle unbroken. In reality, this system can- as satisfactorily applied as steering with pivoted axle To effect the steering of heavy wagons, spur gearing of e purchase has to be used, or a worm and worm wheel The latter seems to answer in one of the best designed s, but I do not consider it as desirable as steering by of spur gearing, since it locks the gear, and besides, a severer strain on the wagon in case the front wheels an obstruction. In rounding a curve, the inner wheels arily describe a smaller circle than the outer wheels. To this practicable, the steering device has to be correctly ed, and the two driving wheels have either to be driven ependent motors, or have to be linked together by means mpensating gear. With a steam wagon it is not neces- use any kind of a clutch while running, seeing that am engine is a very flexible prime mover. Nevertheless, that a speed reduction gear, which can be best provided ans of two sets of spur wheels of varying diameter, one tionary, the other movable axially on a square shaft, forms able adjunct to the mechanism, to be shifted when the is at rest, so as to increase its traction power, and enable it to negotiate any special hill, or extricate the wagon from a bad position.

The next question we have to consider is the boiler and engine. Among the steam wagons built so far, one can notice a great variety of boiler designs. The desiderata of a suitable boiler for a motor wagon are that it should be of the greatest safety, of small proportion, quick steaming and economic. In addition, it should be of the simplest possible construction, and free from joints likely to work loose by jarring on the road. Pipe boilers, while perhaps a little safer than shell boilers, carrying little water, are, for the same reason, undesirable for the varying demands made of a wagon boiler. There are other objections to small calibre pipes; they are necessarily exposed to intense heat and liable to burn, and without a large dry tank they will make wet steam. A shell boiler, on the other hand, can be made of ample proportions, and, if well constructed, and watched during its use, should give no apprehensions as to its safety. The water level can be more evenly maintained, and this is a point of some importance. I consider a superheating device an all-round advantage, provided it is correctly applied to the boiler.

The firing of a wagon boiler, can be most easily effected by means of an oil burner, and with a steam governed burner the firing will automatically respond to the requirements. However, in addition to the inherent disadvantages of using oil, it is difficult to maintain the burner in good trim during all kinds of weather, and at this stage of perfection oil burners will "roar" and occasionally give trouble and make smoke. For the latter reasons coal and coke are preferable, being besides cheaper in use. Solid fuel can be conveniently stowed away, around the boiler, which latter is generally fixed in front of the wagon. In using a shell boiler it is found convenient to fire through the boiler top, a system originally introduced into steam-wagon practice with the De Dion boiler.

The difficulties with which one has to contend in the use of steam wagons are, that they will occasionally show a little steam, and during a sharp frost it will be found difficult to prevent a pipe from being frozen up. "Blowing-off" will be found annoying, but this nuisance is largely caused by neglect of the driver and is suppressible.

The engine so far used is in almost every case a compound. If of vertical design it can be located under the driver's seat; while if of a horizontal type it can be suspended from the body. In all cases a light, and well designed, quick revolution engine will answer the purpose if it be fitted with a reversing gear, and means to admit high pressure steam to the low pressure cylinder. The cylinder ratio should be larger than with stationary practice, seeing that the pressure used is higher, and that a large, low pressure cylinder means a powerful starting moment under live steam, and especial care has to be taken to connect the engine to the frame in an efficient manner. A flywheel is sometimes fitted, and then used as a brake wheel, but I deem it unnecessary.

### ELECTRIC TRANSMISSION.

A timely paper by Prof. William S. Aldrich deals with the systems and efficiency of electric transmission in factories and mills. After comparing briefly the advantages and disadvantages of electric, steam, compressed air and hydraulic transmission, he compared, in a general way, the efficiency of electrical transmission and of the mechanical transmission that the newer system is fast superseding. It is well known that almost all examples of mechanical friction, as in steam engines, shafting, etc., show that power lost in friction is practically constant with all ordinary ranges of loads, provided the speed is constant. He assumes the case of a 275 horse-power engine with a mechanical efficiency of about 90%. From data that he has secured, he estimates that this engine in driving heavy machinery through belts and shafting would deliver 45% of its power for useful work at full load; at three-quarters load there would be only 28% available for work; and at half load there would be nothing left for useful work, all power being consumed in overcoming the combined friction of the engine and the transmission machinery. Other striking examples in mechanical transmission are given in diagram form, showing the heavy losses that have been found to exist with various classes of machinery.

In the electric transmission of power for similar manufacturing purposes, the distances are so short that there is really no necessity for considering any of the so-called line losses which figure so prominently in long-distance electric transmission. The transformation of energy in the electric system from steam power into electric, thence to mechanical power, is accompanied with inherent losses, which are shown in Figs. 4 and 5. In Fig. 4 it will be noted that electric motors have the characteristic feature of high maintained efficiencies at part load.

Three cases of electric transmission are shown in Fig. 4 as follows: Two 100 horse-power motors, four 50 horse-power motors and twenty 10 horse-power motors. The steam engine generating plant required in each case, at normal load rating, will be of 265 indicated horse-power, 275 indicated horse-power and 315 indicated horse-power, respectively. Some interesting features of the electric system are shown in this diagram. In what is probably an extreme case, with only small 10 horse-power motors in service, and these given quite a low rating, it will be seen that at full load (100 per cent.), 63 per cent. of the power applied at the engine is available for useful work; at three-quarters (75 per cent.) load, 62 per cent. of the power is available; at half load (50 per cent.), 51 per cent. of the power is available; while at somewhat less than one-quarter load all of the power applied is required to supply the losses in the engine, dynamo and motors.

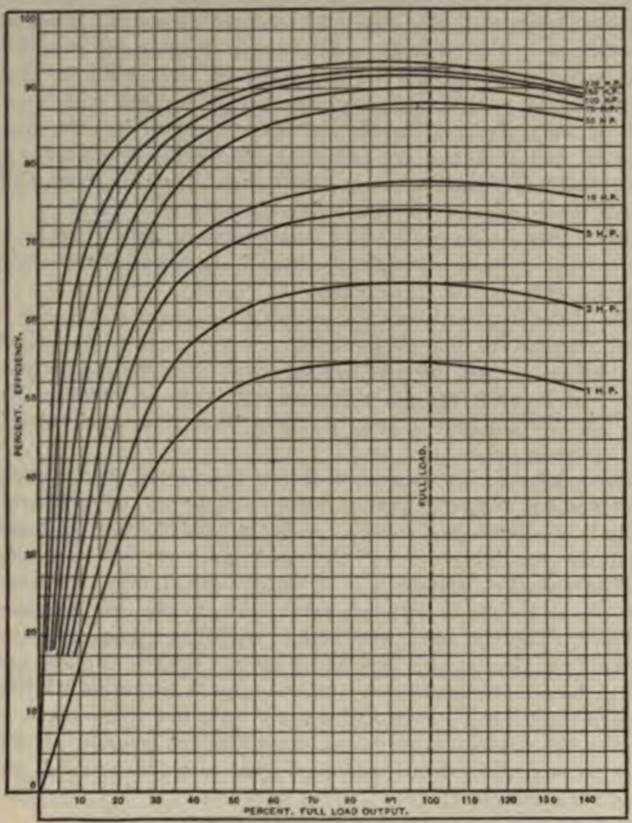


**Fig. 4. Efficiency Curves of Electric Motors of the Same Type, but of Different Sizes, Ranging from 1 to 200 H. P.**

The best performance of the mechanical system of transmission by shafting and belts is at full load. The best performance of the electric system may be maintained from 75 per cent. to 125 per cent. of the full load—from three-quarter load to 25 per cent. overload.

These differences become more vital when it is borne in mind that very few factories and mills are operated at full load all day. For machine shop practice, for instance, an average of about half time for the actual work would be rather liberal. In many shops several machine tools will not be worked much more than one-third of the time. The losses at these light loads are exceedingly expensive for the mechanical system of transmission, but scarcely require consideration in the electric system.

### Systems of Electric Distribution.

In choosing a system of electric transmission for manufacturing work, it is not necessarily best to have that one system which will the most readily lend itself to all of the work to be performed, for light, heat and power service. A composite system may prove best suited, even in such short-distance transmission. That is, lighting service will, in general, be more satisfactory, and need not be more expensive, if supplied independently of the power service. Direct and alternating currents are equally adapted for factory transmission, and by simple or multi-circuit systems of distribution; that is, by two, three, or four-wire systems, as the case may require. Preferably, all distribution should be direct; that is, without the use of storage batteries, rotary converters or transformers, except for certain lines of work in which it may be necessary to use one or the other of these indirect systems of distribution.

In the matter of voltages a wide range is possible: 110-volt two-wire and 220-volt three-wire systems for use of either direct or alternating currents for light and power; 440-volt two-phase alternating-current three or four-wire systems for both light and power; 550-volt direct-current two-wire system, or 550-volt alternating-current three-phase three-wire system, chiefly for power service, or the monocyclic system for both light and power. In general, it will not be necessary nor advisable to use over 550 volts, direct or alternating current. Shocks arising from accidental contact with wires carrying currents of this voltage are not necessarily dangerous. Experience has shown that workmen respect the distributing wires the higher the voltage. But it is not necessary to command such respect by raising it above 550 volts.

### Electric Transmission by Direct Currents.

At the time that electricity was introduced into manufacturing establishments, the direct-current system was the only one available. For the peculiar and exacting service required in driving all kinds of machine tools and various workshop appliances, there were difficulties to be overcome with any system. It was necessary to secure satisfactory methods of producing a large starting turning moment, or torque, for varying the speeds as might be required under uniform or variable loads, and for reducing to a minimum the trouble arising from the use of a commutator.

These difficulties have been almost entirely overcome, and many refinements in design effected, so that the direct-current motor of to-day leaves little to be desired. Such objectionable features as still remain are inherent in the direct-current system used, and are found to lie chiefly in the kind of armature, commutator and brush devices required. These parts are most liable to derangement, require systematic attention for cleanliness and efficiency and renewals of brushes.

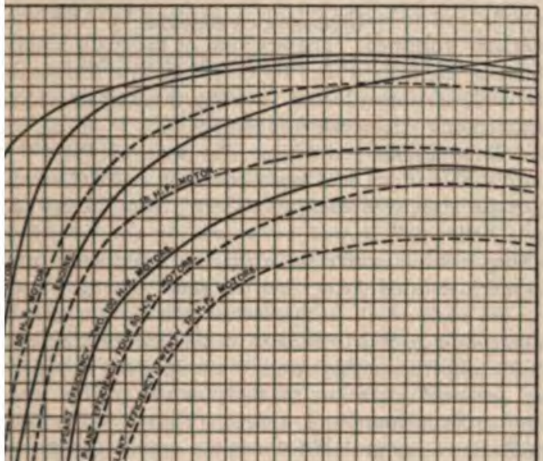
If a motor were sure of the daily care and inspection formerly bestowed upon shafting and belting, it would have made a much better record earlier in its history. Electric motors cannot usually be similarly inspected and attended to while at work as in the case of the older system of mechanical transmission. To have such work performed at any time requires a skilled attendant.

### Electric Transmission by Alternating Currents—Induction Motors.

The alternating current system, with its induction motor service offered practically the only alternative to those engineers and manufacturers who did not care to be troubled with the petty annoyances and delays likely to occur at any time with the direct-current motor. The induction machine as it stands to-day is probably the most perfect motor yet developed from the standpoint of electric transmission in factories and mills. It may be started and operated from any point, at any time, at practically any load and speed within its predetermined ranges. It may be used on 110, 220, 440 or 550-volt alternating current circuits of one, two or three phases. It does not require any direct current supply as the synchronous motor does for its field excitation. It does not require any brushes, commutator or collecting rings. Offsetting these advantages, however, are certain restrictions. The speed of an induction motor falls off slightly as the load is increased, this being known as the slip. The ability to start an induction motor from rest under a heavy load, as well as the possible speed changes during its operation, are obtained at some sacrifice of efficiency.

Induction motors, moreover, permit of higher lineal speeds than are possible with any other type, from 6,000 to 7,000 feet not being infrequent. By suitable arrangements of its field windings, this type of motor may have its speed altered in regular steps, so reducing it one-half, one-quarter, one-eighth, etc. This makes possible similar changes to gear-wheel combinations, which may therefore be eliminated to the extent that the induction motor is installed to effect such changes. In almost all cases of shop driving, the slip is not objectionable, any more than the increasing slip of the driving belt as the load is thrown on.

ors will stand almost any amount of rough usage and rloads, as they cannot be burned out. If excessively l, the motor slows down and stops, starting up im- as soon as the load is lightened. Ordinarily, machine almost all classes of shop machinery are started at loads, and the full load is thrown on when the work l is up to the speed desired. For this class of work ion motor seems specially fitted.



ig. 5. Efficiency Curves for Engines and Dynamos.

r generating power plant is required for an installa- duction motors than would be the case if direct-cur- rs were used. This is on account of the energy which ll classes of alternating current circuits in which there rable self-induction, whether in the transmission wires, appliances used. In the case of induction motors this ry appreciable at light loads, becoming much reduced e and heavy loads, at which it is almost uniform.

### Synchronous Motors.

nous motors are admirably adapted to factory service solute uniformity of speed is required, and where the allation of a direct-current supply for their field exci- not deemed objectionable. While induction motors s wasteful of some energy, through their high self- synchronous motors may on the other hand be nto that condition of operation practically equivalent of direct-current motors, at least for a large range of s. In other words, the power factor of a synchronous y be made almost anything from zero to unity, accord- extent of excitation of its fields by the direct current r this purpose.

made in the revolving field type, synchronous motors tarting from rest, at light loads. They may be very verloaded, without falling out of synchronism or out nd when they do for an instant, they may be brought n by throwing off some of the load. A well-designed ous motor will carry at least three times its full nor- and not drop out of step. If an induction motor is such overloads it is likely to have quite low efficiency ry loads.

efficiencies may be obtained with synchronous motors induction motors of the same output. In fact, such ealize the ideal conditions of motor working in which r attains almost the same efficiency as the generatory. uction and synchronous motors have usually higher s than direct current motors of the same size.

### ined Induction and Synchronous Motor Working.

al conditions in a factory installation no doubt would d where both induction and synchronous motors were former for small machines and direct driving, the latter ting a set or group of machines. The synchronous motors would be started up just before beginning the work of the day, have at all times a light constant load, and might easily be so regulated as to produce an almost balanced system in combination with the induction motors. In such a system of transmission the lagging currents of the induction motors would be offset by the leading currents of the synchronous motors, if the latter were operated to produce such leading currents. The whole system would be operated practically throughout quite a range of load variations, as if it were a simple, direct current system.

The advantage of such a condition is apparent; it means least installation for any given output, or greatest output for any given capacity of generating plant. The group method of electric driving is much better adapted for small machines, up to and including 2 horse-power capacity, and especially where such machines are in almost constant service. Above this size, individual motor driving becomes more and more efficient, particularly if the machines are operated only a fraction of the day.

### TESTS OF POWER PLANTS.

As usual the data contained in the reports of the past proceedings are added to by reports of tests made upon steam engines and power plants. Three of the papers are devoted to tests of this character. One of these, which was prepared by M. E. Cooley, F. C. Wagner and J. R. Allen, contains nearly 100 pages and is so elaborate that it is scarcely possible to give a satisfactory abstract. A complete test was made of the boilers and engine, together with the accessories, at the Grand Rapids Water Works, Grand Rapids, Mich. The engine is a triple expansion, Nordberg high-duty pumping engine of 15,000,000 gallons capacity. The high-pressure cylinder is 21" diameter, the intermediate cylinder 37", the low pressure 55", and the stroke 4'. Re-heating receivers are placed between the first and second, and the second and third cylinders. A jet condenser is used and a feed-water heater, and the pumps are worked against a head of about 170 feet. The boilers are of the Babcock & Wilcox type.

The report of the test contains a detail description both of the main and auxiliary machinery of the plant, with many indicator diagrams, both separate and combined. The results refer not only to the duty of the pumps and the efficiency of the boilers, but include such items as the valve friction, the performance of the air and feed pumps, the efficiency of the feed water, etc., thus making the report of great value to the student of steam engineering.

The cylinders of the engine are steam-jacketed, and it is interesting to note the effects of the jackets and of the re-heaters. After the regular test, which lasted six days, two runs were made, one at the three-quarter speed and the other at half-speed. In comparing the average results at the different speeds, it was found that the percentage of steam used by the jackets and re-heaters increases as the speed decreases. At full speed this percentage was 13.7%, at ¾ speed 15% and at ½ speed 17.9%. It is interesting to note, also, that the re-heating effect was such that the steam account for by the indicator increased from cylinder to cylinder. In the high-pressure at 9/10 stroke, about 85% was accounted for. In the intermediate, 97%, and at 9/10 stroke in the low pressure practically 100%. The indicator does not show, of course, steam used in the re-heaters and jackets. The engine at full power ran with an average consumption of 12.7 pounds of steam per H. P. per hour; at ¾ speed, 13.3 pounds, and at ½ speed, 17.9 pounds. The duty per million heat units is 134,600,000, which is in excess of contract requirements.

A test reported by Prof. W. F. M. Goss, which was made under his direction upon a 20,000,000 gal. pumping engine at Indianapolis, Ind., is of exceptional interest, because this engine held the world's record for high duty until within a short time. The only engine that has surpassed it is the Nordberg pumping engine at Pittsburg, Pa., a test of which was reported by Dr. Thurston at the last meeting of the American Society of Mechanical Engineers. This latter engine has a peculiar arrangement of heaters whereby the feed water is brought nearly to the temperature of steam in the boiler, and which resulted in an exceptionally high performance. Without this system of heaters, the engine failed to equal the performance of the Snow engine.

The Snow engine is designed to pump 20,000,000 gallons in twenty-four hours. It is of the vertical, triple-expansion type, having a single-acting plunger pump below, and in line with

(Continued on page 303 )

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# MACHINERY

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## JUNE, 1900.

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| 1899. | | 1899. | | 1900. | |
|---|---|---|---|---|---|
| July ........ | 16,650 | December ... | 18,500 | April ....... | 21,500 |
| August ...... | 17,150 | 1900. | | May ........ | 21,500 |
| September .. | 18,000 | January ..... | 20,000 | June ........ | 27,500 |
| October .... | 17,500 | February ... | 20,500 | | |
| November .. | 17,750 | March ...... | 25,000 | | |

## THE PARIS EXPOSITION.

As is apparent from the photographs shown in the first section of this issue and as is usually the case with an ephemeral undertaking like the great Paris Exposition now in progress, there is much delay and confusion in getting the buildings and exhibits into shape. From the nature of a great international fair, the work of marshalling together and organizing the exhibits into presentable shape is one of great difficulty, requiring executive ability as well as experience in these peculiar undertakings. One prominent cause of difficulty, which is very much in evidence in this case, is that many of those who should have been the most prominent exhibitors have delayed their requisitions for space until such a late date that their requests could not be granted in full and they have consequently found themselves restricted to ridiculously small quarters, where none of their products could be advantageously placed.

The dilatoriness of the United States officials in asking for space is peculiarly unfortunate to American machinery builders, as the space in the Champ de Mars is so restricted that a supplementary exhibition has been arranged at Vincennes, which is about four and one-half miles from the Champ de Mars. While our machinery exhibitors will here undoubtedly have ample space and opportunity to exhibit their machines to the best advantage, they are put in the somewhat undesirable position of side-show exhibitors and will not have the prestige of the Exposition proper. On the other hand, the American machinist and the foreign manufacturer who are interested in American machinery will certainly not neglect the opportunity to visit the Vincennes exhibit, where the latter will be introduced to American methods and to a shop built according to American ideas by American workmen. The erection of the main building for this exhibit in eight days and by only fourteen American workmen is in itself an object lesson showing the energy and promptness characterizing American mechanics.

An international exhibition like that of Paris or our own World's Fair of '93 is a great educator and the effects on trade are of the most significant character. The old saying that "seeing is believing" is well borne out by the results of practical working exhibits where the actual operations are carried on before the interested party. At the same time personal acquaintances are made which in themselves are a most valuable asset to the man who desires to succeed in the commercial race. Another valuable experience that American exhibitors will gain who give their personal attention to their exhibits, is a knowledge of Continental customs and usages. These, which appear so insignificant to our practical American manufacturers, are often of the most vital significance, and if neglected will eventually lead to their undoing. There can be no doubt that the enterprising American manufacturer who expects to do business in Continental countries, must educate himself to an understanding of the peculiar conditions to be met, and the opportunity presented by the Paris Exposition is one that the wide-awake man will avail himself of.

* * *

## LATHE SPINDLES.

A purchaser of machine tools will sometimes insist upon "up to date" features that are quite commonly assumed to be essential to the best results, when, as a matter of fact, the exact reverse may be true when the class of work that is to be done is taken into consideration. A particular instance is in the specification often made that the hole through the spindle of a lathe shall be of large diameter, though in many cases the purchaser has only a vague idea of what will be done with the "hole of large diameter" when he gets it.

It is true that for special work it may be necessary to have a good sized hole through the spindle to successfully handle it, and there is occasionally a piece that it seems almost impossible to hold in the chuck and operate upon unless there is this feature. In small shops, where the lathe has to do work that ordinarily would be done in the screw machine, and when lathes are equipped with a turret slide so that they may be used either as a lathe or a screw machine and work up stock from the bar, the large spindle hole is a necessity. Where lathes are used strictly for lathe work, however, and screw machines for screw machine work, the large hole may be a disadvantage, rather than otherwise.

Take the case of a 16-inch lathe, with a spindle, say, 2½ inches outside diameter. Suppose the lathe were ordinarily made with a one-inch hole through the spindle, with the idea that this size would enable a bar to be passed through the spindle and would answer the requirements for small screw machine work. This would give a spindle with reasonable stiffness for heavy work. If, instead of the one-inch hole, a 1½-inch hole were ordered, the spindle would lose about 12 per cent. in stiffness and the amount that the spindle would lose for each increase in diameter would be much greater in proportion than this increase. Thus, the increase from 1¼ inch to 1½ inch would weaken the spindle almost twice as much as the increase from one inch to 1¼ inch. It does not always pay to go to extremes, even with "up to date" features.

The same line of reasoning, however, will show that, given a spindle with a large hole through the center, the loss in strength can be compensated for by slightly increasing the outside diameter of the spindle. This increase can be considerably less than the increase in the diameter of the hole in order to secure the ffness that the spindle would have with a small hole. : hole is insisted on by a customer, a spindle of generous diameter should also be specified. The tendency of n manufacturers is to furnish spindles that are so large amply stiff, even when an unusually large hole is called s more of an up-to-date feature to have a spindle thus , than to have a smaller spindle with a larger hole, and e point that should be looked out for.

* * *

(Continued from page 301.)

## ABSTRACT FROM PAPERS.

the three steam cylinders. The steam cylinders are 29, o inches in diameter, respectively, the pump plungers nches in diameter, and each has a stroke of 60 inches. ing-rods from the cross-heads of each cylinder couple nks set at 120 degrees, and upon the crank shaft are two ywheels.

am cylinders are jacketed on barrels and heads, and ils in the intermediate receivers, presenting a surface of are feet, serve as reheaters.

gine pumps against a pressure of 89 pounds, and has d a duty of 147.5 million foot-pounds per million British units. The steam consumption per indicated horse- er hour is 11.38 pounds. A perfect engine working e same pressure ranges would require 9.2 pounds. A on is made between this engine and the three others the present time, stand in practically the same class as efficiency. The first of these is the E. P. Allis engine at ee, tested by Prof. R. C. Carpenter; its cylinders are nd 74 x 60. The I. H. P. is 573.9; the steam, 11.68 and the duty, ~~137.7~~ million. The second one is the eavitt engine at Chestnut Hill, Mass., tested by Prof iller. Its cylinders are 13.7, 24.37 and 39 x 72. The horse-power is 575.7, the steam consumption 11.22 and 144.5 millions. The Nordberg engine has cylinders 19.5, nd 57.5 x 42, being a quadruple expansion engine. The wer is 712, or about 70 less than that of the Snow en- steam consumption is 12.26 with the heaters and 11.4 the duty is 162.9 and 147.5 millions.

ird test referred to was reported by E. H. Foster, of England, and shows the effect of superheated steam on omy of a Worthington, duplex, direct-acting pumping This engine is a triple-expansion engine of small size, ders 12", 18" and 29" in diameter and the stroke 18". und that if steam were superheated about 125 degrees do 16% more work than when saturated. Taking into the heat required to superheat this steam, it was found h the feed water passing through an exhaust heater, a nount of fuel would produce from 11% to 12% more he engine was jacketed and tests were made both with out the jackets. The effect of the jackets was to produce of only 4% of the fuel or 3% of the feed water under e-named conditions of steam superheated and feed water

## NG BY HOT WATER FROM A CENTRAL STATION.

paper upon heating by hot water from a central station, T. Yaryan, Toledo, Ohio, makes the somewhat startling t that "if some great genius, like an Edison or a Tesla, announce to this society that electricity could be pro- ithout cost, I imagine there would be a sensation; and Toledo Heating and Lighting Company is doing this g, as the six months' business ending January 1st last e record being 199 houses heated and 450 lighted."

| | |
|---|---|
| ipts from heating | $9,900.88 |
| ipts from lighting | 9,064.78 |
| enses | 9,764.54 |

stem that he refers to is a hot-water heating system onjunction with an electric lighting system, the exhaust om the engines driving the generators being utilized to water for heating purposes. The hot water is circu- a distance of ¾ mile from the central station and so has the system been found, largely because the increase ase in the demands for both heating and lighting go de, that after an experience of five years it is pronounced .

stem, which is shown in Fig. 6, is so simple that but few words are necessary to make it intelligible. The steam boilers, engines and dynamos are such as may be used in the ordinary electric light station. Heaters of the tubular type, through which the water passes from the pumps to the mains, receive the exhaust steam from the engines, heating the water to any desired temperature. When more exhaust is being produced than is required to heat the water, the excess is delivered to a water-storage tank to be used later when the output of electricity is small. The circulating system consists of two wrought-iron pipes, laid side by side in the ground, carefully protected by insulation, one pipe for the outflow of hot water impelled by the pumps, the other for the return water from the coils in the various houses heated, going back to the suction end of the pumps, to be forced again through the heaters, where the loss in temperature is restored.

The amount of coal consumed amounts to about 25 short tons per residence. These same buildings, if heated by their own furnaces, would average not more than 18 tons of hard coal each. The difference may be accounted for by the loss of heat in ground radiation, and largely by the fact that we heat the buildings more thoroughly and for a greater number of hours than they could or would do by private furnaces. The loss of heat through radiation in the mains is an important one, and probably amounts to 20 or 25 per cent. The water reaches the extreme end of the lines, three-quarters of a mile from the station, in the coldest weather, with a loss of 12 degrees Fahr., which would be an average of 6 degrees to all of the houses. As the water returns to the station with a drop of 35 degrees, this would indicate about 17 per cent. loss in the ground. A pressure of 60 pounds is maintained on the feed line during cold weather and 40 pounds during moderate weather. The service pipes to the various houses are 1-inch pipe, and the return line throttled with a disc inside the building, the size of opening depending upon the quantity of radiation, but average ⅝ of an inch. The houses are equipped with radiation sufficient to heat them to a temperature of 70 degrees Fahr., with water entering the house at 160 degrees Fahr., when the outside temperature is freezing. By raising or lowering the temperature of water one degree for each degree of variation in the outside temperature, we are able to maintain a constant temperature in the houses during all kinds of weather. There is no occasion for the consumer to regulate the flow of water during the entire winter, and with few exceptions our consumers open the supply valves in the fall and only close them in the spring. The extreme limits of temperature of the water is from 130 degrees in moderate weather to 212 degrees in the coldest.

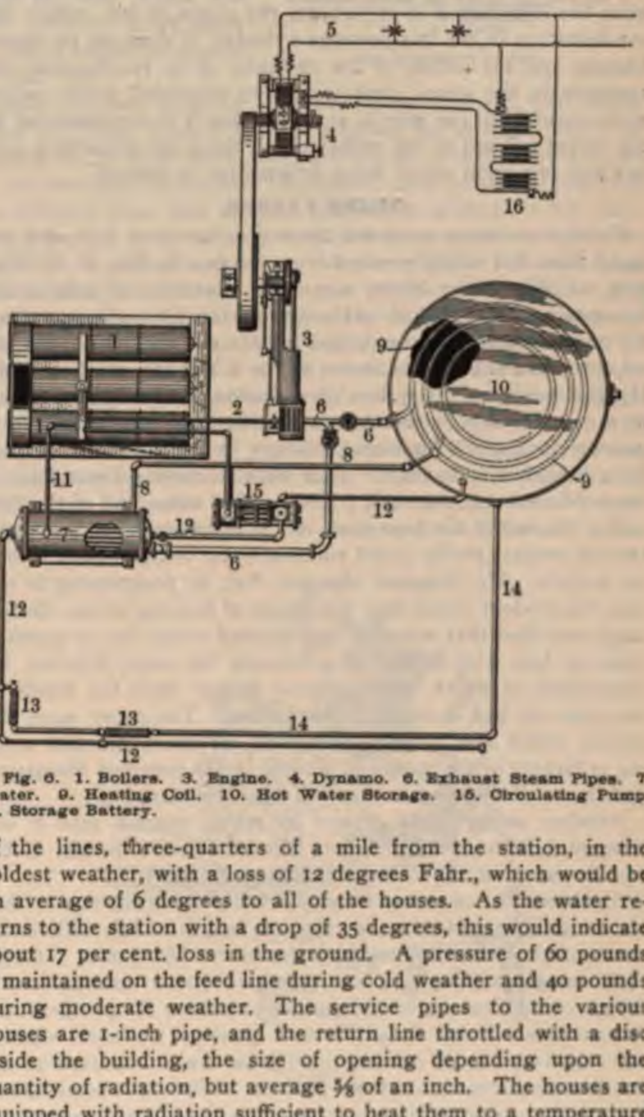


Fig. 6. 1. Boilers. 3. Engine. 4. Dynamo. 6. Exhaust Steam Pipes. 7. Heater. 9. Heating Coil. 10. Hot Water Storage. 15. Circulating Pump 16. Storage Battery.

### THE USE OF REHEATERS.

Many of the leading steam engine builders are equipping their large multi-cylinder engines, which are intended for a high economy, with re-heating receivers placed between the engine cylinders. Dr. Robert H. Thurston has attempted to gather together, in a paper upon this subject, a statement of the advantages or disadvantages, of the re-heating receiver, but with only a fair degree of success. A number of leading builders express their opinion that the use of the re-heater improves the economy and that it is of sufficient value to warrant its use, although none of them appear to have any accurate data on which to base their opinions. There are but few tests available upon this subject, and those that are available are more or less contradictory. Those quoted by Dr. Thurston show a gain in economy of from 2 to 8 per cent. from the use of the re-heater, but in most instances the gain was so small that it is a question whether it would warrant the necessary expenditure for the equipment. Dr. Thurston points out that, both as a result of theory and of experiment, the re-heater, in order to be effective, must superheat the steam. If there is so much moisture in the steam when it enters the receiver that the re-heater fails to superheat the steam before it enters the next cylinder, he points out that it is best either to abandon the re-heater or to first eliminate the moisture by separating. The advantage of the re-heater comes simply from the fact that if it superheats the steam it will reduce the condensation in the low-pressure cylinder; if there be no superheating and the action of the re-heater is to re-evaporate the moisture in the steam, thus producing saturated steam, which easily condenses, the gain is so slight that it is overbalanced by the steam utilized in the re-heater. This is an interesting subject and one upon which more information is needed.

### OTHER PAPERS.

Perhaps no more extended discussion has been accorded any paper than that which resulted from the one by Mr. M. T. Higgins, of Worcester, Mass., upon the education of machinists, foremen and mechanical engineers, at the December meeting. So much interest was awakened in this subject that it was decided to continue the discussion at the Cincinnati meeting. Mr. Higgins proposed his system of education whereby there should be a commercially successful shop where students should have practice during half the working hours, in five days of each week for a period of four years. They were to receive instruction in the public schools during a portion of the other half of the time and at the end of the four years it was calculated that those who showed natural ability could continue their course in the technical schools. Mr. Higgins' idea was that, by progressing in this way, the student could drop his course of training at any desired stage and find that what he had learned would be of practical value to him, and fit him in a measure for some position, the importance of which would depend largely upon the length of time that he had devoted to his studies. The paper upon this subject which Mr. Higgins presented for the Cincinnati meeting is largely in the nature of a reply to the previous discussion, and is not of a character that will bear summarizing.

Another subject that evoked so much interest that it was thought best to bring it before another session is Mr. Rockwood's paper on the "Value of a Horse-Power."

A subject that comes up for discussion periodically is a method for designing speed cones, so that the length of belt will remain constant for each pair of steps of the cones. Mr. James J. Guest, of Birmingham, England, has submitted a new formula for the design of such cones, which appears to reduce the problem to a comparatively simple form. It is a question, however, whether the requirements of practice justify so much attention to the mathematical treatment of this problem. When it is remembered that, in the majority of cases, these cones are placed several feet apart and are connected by a belt that will run efficiently when it is either stretched or tightened an amount that is several times greater than the greatest error of the graphical method, it would seem that in most cases the approximate method was sufficient. When greater accuracy is desired in special cases, it is not a serious matter to calculate a set of speed cones by trigonometrical methods.

An extended paper that will be of interest to those in any way connected with the gas engine industry is that by Prof. Wm. T. Magruder, Columbus, O., upon the gas engine hot tube as an ignition timing device. A great many indicator cards are shown to illustrate the variable conditions upon which the time of igni tion may take place. A study of these conditions was made witl the belief that they must be fully understood before accurate dat can be obtained upon gas engine performance.

N. O. Goldsmith, Cincinnati, O., presents a brief descriptio of a water-softening plant in use at the Lorain Steel Co.'s blas furnaces. The available water supply contains a number of im purities, of which lime and magnesia are important element that produce a hard boiler scale. These are precipitated by mear of caustic lime and soda ash, which are introduced in exact an known proportions. Intermittent settling tanks, in which ther are devices for mixing, are used for the treatment. The precip tate is finally removed by filtering and frequent analyses are mad to insure the correct quantities of chemicals.

At one of the junior meetings last winter Mr. B. C. Ball, Ne York City, gave a carefully prepared discussion on cylinder pr portions for compound and triple expansion engines. This pap is highly technical, though not mathematical, and was presente at Cincinnati.

* * *

## THE CONVERSION OF FORMULAS.—2.

### ADDITIONAL ILLUSTRATIVE EXAMPLES.

J. J. C.

The two following examples of the conversion of formula from one system of units to another are as difficult as will ofte be met with, but the methods used in each case will be under stood by referring to the explanation and examples in the las number:

Problem 5.—Kutter's formula as originally stated is

$$v = \frac{23 + \frac{1}{n}\Big( + \frac{.00155}{s}}{1 + \left(23 + \frac{.00155}{s}\right)\frac{n}{\sqrt{r}}}\sqrt{r\,s}$$

in which v = velocity in meters per second, r = hydraulic mea radius in meters, n = coefficient of roughness, and s = sine angle of slope. Convert so that v and r will be in feet.

Solution.—The only variables entering into the formula are and r; hence,

$$\frac{[v\times3.2809]}{3.2809} = \frac{23 + \frac{1}{n} + \frac{.00155}{s}}{1+\left(23 + \frac{.00155}{s}\right)\frac{n\sqrt{3.2809}}{[\sqrt{3\ 2809r}]}}\sqrt{\frac{[r\times3.2809]s}{3.2809}} \quad \text{(a)}$$

$$\text{Or, } v_1 = \frac{\left(23 + \frac{1}{n} + \frac{.00155}{3}\right)3.2809}{\sqrt{3.2809} + \left(23 + \frac{.00155}{s}\right)\frac{n\times3.2809}{\sqrt{r_1}}}\sqrt{r_1\,s} =$$

$$\frac{23 + \frac{1}{n} + \frac{.00155}{s}}{\frac{1}{\sqrt{3.2809}} + \left(23 + \frac{00155}{s}\right)\frac{n}{\sqrt{r_1}}}\sqrt{r_1 s}$$

Whence, dropping subscripts,

$$v = \frac{23 + \frac{1}{n} + \frac{.00155}{s}}{.55208 + \left(23 + \frac{00155}{s}\right)\frac{n}{\sqrt{r}}}\sqrt{r\,s}$$

Whoever first converted this formula obtained the very u wieldy expression,

$$v = \frac{41.66 + \frac{1.8113}{n} + \frac{002807}{s}}{1 + \left(41.66 + \frac{.002807}{s}\right)\frac{n}{\sqrt{r}}}\sqrt{r\,s}$$

which is easily obtained from equation (a). This latter form one generally used, and, so far as the writer is aware, he is t

state it in the form derived above. The new form is
be preferred.

lem 6.—Rankine's formula giving the relation between
ssure and temperature of saturated steam is, according to

$$\text{Log } p = 8.28203 - \frac{2763\ 59}{T} - \frac{383683}{T^2}$$

h p = pressure in pounds per square foot and T = abso-
nperature Fahrenheit, the freezing point being taken as
absolute. Convert the formula so that p may be taken
ds per square inch and the freezing point may be taken
absolute.

ion.—At 32° F., the absolute temperature before con-
will be 492.66°, and after converting, 492°; hence, if we
change the freezing point from 492.66° to 492°, we must
the reading at 32° F. before the change by $\frac{492}{492.66}$.
or 32°, $T = 492.66$ in the formula, and we desire to change
mula so that T will be 492. Proceeding as before,

$$\log\left\{\frac{\left[p \times \frac{1}{144}\right]}{\frac{1}{144}}\right\} =$$

$$8.28203 - \frac{\frac{2763.59}{\left[T \times \frac{492}{492.66}\right]}}{\frac{492}{492\ 66}} - \frac{\frac{383683}{\left[T^2 \times \left(\frac{492}{492.66}\right)^2\right]}}{\left(\frac{492}{492.66}\right)^2}$$

$$p_1 + \log 144 = 8.28203 - \frac{2763.59 \times \frac{492}{492\ 66}}{T_1} - \frac{383683 \times \left(\frac{492}{492.66}\right)^2}{T_1^2}$$

nce, dropping subscripts,

$$\log p = 6.12367 - \frac{2759.89}{T} - \frac{382656}{T^2}$$

is an extremely unsatisfactory formula to convert, since
ly for a temperature of 32° F. that the formula will give
the same values for the pressures after conversion as be-
The reason for this is readily found. Let $T_0$ represent
olute temperature at 32° before conversion, $T'_0$ the same
onversion, and t the temperature of the steam above 32°.

$$= \frac{1}{T_0 + t} = \frac{1}{\frac{\left[T_0 \times \frac{492}{492.66}\right]}{\frac{492}{492.66}} + t} = \frac{\frac{492}{492\ 66}}{T'_0 + t \times \frac{492}{492.66}}$$

ther words, to obtain identical results, t must be multi-
y $\frac{492}{492.66}$ before adding to $T'_0$. This is never done in
e, the reading of the thermometer less 32° being always
Since the original formula is purely empirical, the slight
nce in the results may be neglected. If the original for-
ad been based on temperatures indicated by thermometers,
of absolute temperatures, the conversion could have been
xactly.

* * *

ood scheme to follow in cross-sectioning tracings is de-
by a writer in the "Mechanic Arts Magazine," who says
never sections the original drawing accurately but merely
es the sectioning roughly. After the tracing is ready for
he places a piece of stiff paper with lines about 1-16"
under the tracing paper and traces the required section-
f the sectioning is to be fine, every line is traced; but if
only alternate lines are traced, or every third line for
arse work.

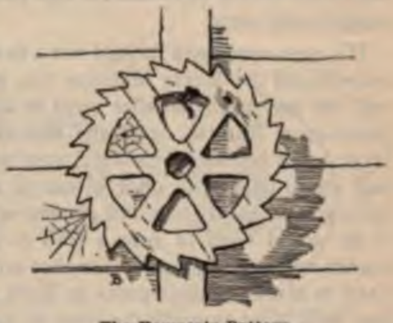
# THE EVOLUTION OF ARCHIMEDES.—3.

### A TRUE BIOGRAPHY.

JUNIUS.

Now Ahaz was foreman of the woodshop at Bang & Ammer's and also did what pattern making there was to do. This latter was no small item in a country job shop and many of the patterns would have done credit to a modern pattern maker. For Ahaz never hurried and always took time enough to pare and gouge, and putty and polish, until the pattern was right.

Sometimes a pattern came in from the country, made at some farmer's fireside, and these usually had to be made over to bring the shrinkage and the draft and the finish where they should be. One pattern of a ratchet wheel about a foot in diameter hung on the wall over Ahaz's bench for many years, a curiosity. It had been sawed out of inch pine by some rural genius with a compass saw, and, in all good faith, it was brought to the shop, with the saw marks and the splinters fresh upon it, that it might be moulded and cast.



The Farmer's Pattern.

Ahaz's strong point in his own estimation was gear teeth. After the blank pattern had been turned up and the pitch line scribed on the fresh wood, Ahaz got out his best dividers and put on his strongest spectacles. He spaced away patiently, changing his dividers from time to time and finally getting to the stage where he had to whet the points first on one side and then on the other, to make the divisions come out right. The next thing was to draw the tooth outlines and here was where Ahaz' superior knowledge came into play. He would carefully draw one tooth either on the wood or on paper, using circular arcs for the outlines. If he wanted a strong tooth he made it broad at the base; if a "light, free-runnin' tooth" was what seemed desirable, he shortened up his dividers and made the tooth slender, with beautiful reverse curves. Cycloids, involutes, describing circles and obliquity had no terrors for him; he had never heard of them, and "where ignorance is bliss, etc." After he had made his templates and transferred the curves to the pattern, he would sometimes modify them a little, turning his head from side to side and looking at them as an artist at his painting. When Archimedes asked him how he could tell, he said he knew by the looks when a tooth would run easy. And then he observed wisely: "If you don't get her just right, she will soon wear into shape." (We all know now that this is not so; nothing ever wears into shape, but everything wears out of shape, gear teeth, roads, nerves or religion; such is life.) It was this problem of gear teeth that first set Archimedes to thinking. He was bright enough to see that Ahaz' reasoning was at fault and that a gear tooth must be right or wrong, irrespective of the condition of Ahaz' eyesight or liver. Writing to a very good friend of his in Boston for help and in-

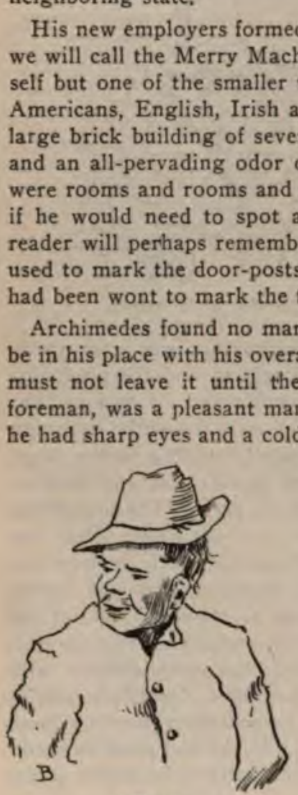
"Ahaz."

formation, Archimedes finally secured a book on drawing and some instruments. Then began the struggle with arcs and tangents, cycloids and involutes, when the fingers, stiff from the use of hammer and chisel, refused to curl around the drawing pen, and tired nature rebelled at the midnight oil racket. Archimedes sometimes went to sleep over the drawing board and sometimes got discouraged, but on the whole he enjoyed it and he persevered until he had drawn everything in the book (Cassell's Mechanical Drawing, I believe it was). I am afraid, however, that teeth constructed by methods there learned would not have run much more smoothly than those generated by Ahaz' critical instinct.

The upshot of it all was that our subject became dissatisfied with his country environment and emigrated to a city shop, in a neighboring state.

His new employers formed not a firm, but a corporation, which we will call the Merry Machine Co., and Archimedes found himself but one of the smaller units in a medley of several hundred Americans, English, Irish and Germans. The shop itself was a large brick building of several stories, numerous ells and wings, and an all-pervading odor of rancid oil and soda-water. There were rooms and rooms and rooms, until our country man felt as if he would need to spot a trail to prevent getting lost. The reader will perhaps remember that one of Conan Doyle's heroes used to mark the door-posts in Paris with his hatchet, just as he had been wont to mark the trees in his own Canadian forest.

Archimedes found no margins now on his time card; he must be in his place with his overalls on when the whistle blew, and he must not leave it until the whistle blew again. "James," his foreman, was a pleasant man and kind to the country youth, but he had sharp eyes and a cold, stern voice for the transgressor.



"Pat."

The Merry Machine Co. had a tool room on each floor, one vertically above another, in a fireproof tower, with tin-lined doors. This may not seem worth mentioning, but it was a great revelation to Archimedes. To be able to go to a room like this with everything in order and get what tool or mandrel he needed all ready for use, was something new in his experience. But to have to carry them back again and not keep favorite tools in his chest or his drawer, there was the rub. And then Pat, who had charge of the tool room on this floor, was inclined to be crusty and to think he knew much better than a green country lad, what tap or reamer was needed. The company built interchangeable work and had an elaborate system of gages, plugs and collars for standard sizes. Queerly enough, as they had originated their own system at a time when standard gages could not be bought, most of the sizes were arbitrary and did not represent inches and sixteenths. Once begun, the system had to be carried out, and it gave them a monopoly of their repairs.

Although Archimedes felt like a cat in a strange garret, he soon lighted on his feet. He was tried at first on simple jobs of turning and fitting, but a man who has learned to make fits in a country job shop, with stick and calipers, soon tumbles to the use of a plug gage, and one who has had to locate holes with a prick-punch and bore them with a flat drill, finds the twist drill and jig business a cinch. In short, James the foreman soon discovered that, as the new man was not dependent on jigs and gages for close work, he would be a good man to make those same jigs and gages. An apprenticeship in a country shop, where one has to do much with little and to invent the tools as he goes, gives a self-reliance and independence which the more favored craftsman often lacks. Archimedes felt much more at home in making a jig from the raw material than in using one. He enjoyed laying them out from the drawing with surface gage, square and scriber; marking the holes to be drilled with dividers and center punch; drilling carefully with a thin-pointed drill, correcting at the start with a chisel, until the lips of the drill just touched the circle of punch marks; and so on until the final testing of the jig on a casting satisfied the keen eyes of James. Archimedes did have some struggles with the twist drill at first, until he learned to grind both lips the same, and he sometimes longed for his old, flat-footed friend.

All the planers were located in a room by themselves and formed a little kingdom at one side with "Jim" for its monarch. Why is one foreman always "James" and the other "Jim"? Jim was very proud of his room. He could take a bar of machinery steel, cut it up into pieces, and by a series of skilful operations, planing twenty or more pieces at a time, manufacture small machine parts at a surprisingly low cost. Jim had a great contempt for milling machines, and, indeed, at that time, the milling machine was only a lusty, growing child, just cutting its teeth, as you might say, and with a great appetite for oil. I am afraid that to-day that planer room could hardly hold its own with the milling machine. Archimedes had never seen a milling machine, and although he soon learned to use one, he never liked its growling, squeaking ways, its splintery chips and the smell of hot oil and soda water which always went with it.

"Jim."

As has already been said, there were all sorts of nationalities in the shop and it was quite a liberal education to hear them talk, a sort of lingual hash, so to speak, with various flavors. Archimedes did not try to understand the Germans, got along finely with the Irish and then ran up against a stump in the Yorkshire dialect. It seemed to him that the Englishman must have learned his vowels with his eyes shut, they were so badly mixed. One day a native of Yorkshire was up on a ladder, oiling and wiping the countershaft of his lathe, and, seeing Archimedes below, he called in stentorian tones: "Wull yer 'ond moy ther breesh?" Archimedes simply opened his mouth and stared. Again came the cry from above. This time another Englishman came to the rescue and handed his compatriot a brush, while Archimedes thoughtfully contemplated "English as she is spoke."

The line shafting in this shop was well loaded with pulleys and a perfect maze of belts, weaving in and out to the long lines of lathes, so that it was no easy matter to mend a belt or oil a shaft. One day a new hand noticed that the long belt from the counter of his lathe to the line shaft was slack and needed mending. Getting a shifter from the tool room, he ran the belt off the pulley, where it very promptly began to wind up. Seeing the danger, the man yelled to his mates and ran. Just in time, for in an instant more the countershaft tore from its moorings with a crash, swung whirling through the air and finally landed atop of an engine lathe, making a nest for itself as it twisted and squirmed in its last struggles. Fortunately, no one was injured, but the accumulated time of a hundred idle men, during the fifteen minutes of shutdown worried the foreman for a week. Moral: Don't wind up a belt, lest it wind up your career.

Talking English.

\rchimedes was now working on special tools, he got well nted with John, the pattern maker, and they soon became riends. Times were brisk now, lots of work and every one ırry. They found out in some way that Archimedes could little and rightly conjectured that he would not object to to his income by drawing overtime. John made him a rawing-board and he began to get up at four o'clock these mornings and put lines on paper. It required consider-ill power to do this and his stomach rebelled, but twenty ın hour meant a great deal just then. There is this to be hat when a boy works ten hours a day in the shop, draws ır every morning and studies mathematics in the evening, idle hands, etc., are not in the equation.

es were so good and work so plenty that pattern makers e scarce and hard to get. The company conceived the idea of hiring in a couple of experienced cabinet makers, g that with John to show them how they would soon catch t was a unique experience. In one sense green hands have done better, for the cabinet makers knew such a lot ıgs that were not so when applied to pattern making, as to ɛtely discourage their teacher. They panelled everything ent warping, were very particular about sharp corners and ıngles, and abhorred such a thing as draft. As to any con- of getting a pattern into the sand or out of it again, that ır from them. After throwing away several nicely made ıs and making over as many more, John had to give it up scharge the experts.

* * *

## GAS ENGINE DESIGN.—7.

E. W. ROBERTS.

opening the valves of a four cycle engine in which the op- is performed by means of a cam driven so that it makes volution to two of the engine crank shaft, the cam itself, ıer the shape of the cam, is perhaps as important a matter thing about the design of the entire valve mechanism. The quisite of a cam is that it shall open the valve which it is ed to operate at the proper point in the stroke and that it perform this operation with the least possible delay. In words, it is desirable, as in the steam engine, to open the and also to close them in the shortest possible time. If, er, the highest possible speed is given to the opening and osing of the valves, the outcome is a mechanism that is ıoisy and for this reason objectionable. An attempt to the cam after theoretical ideas, so as to open the valve constantly accelerated motion and to close it with a gradu-tarded motion or negative acceleration, will usually result oisy device. The cause of this noise is the fact that valve s do not operate rapidly enough to follow the curve of the n closing the valve and that upon opening the valve the ill strike the roller a blow.

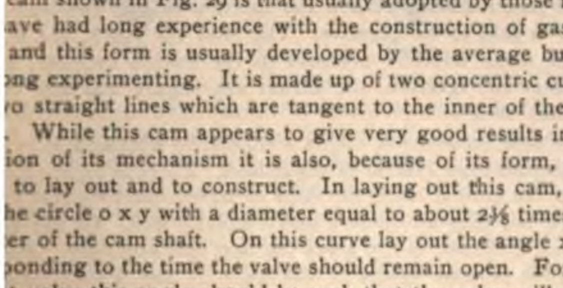


Fig. 29.

cam shown in Fig. 29 is that usually adopted by those firms ave had long experience with the construction of gas en- and this form is usually developed by the average builder ɔng experimenting. It is made up of two concentric curves o straight lines which are tangent to the inner of the two . While this cam appears to give very good results in the ion of its mechanism it is also, because of its form, very to lay out and to construct. In laying out this cam, first he circle o x y with a diameter equal to about 2⅜ times the er of the cam shaft. On this curve lay out the angle x a y ɔonding to the time the valve should remain open. For the t valve this angle should be such that the valve will open the piston has completed 90% of the expansion stroke should close just at the end of the exhaust stroke. Since the cam shaft makes one-half revolution to one of the crank shaft, the cam shaft rotates through a quarter revolution or 90° while the piston is making one complete stroke. The opening of the exhaust should therefore be during 90° + (90° × .10) = 99 degrees or say 100 degrees for the entire opening of the valve. For the inlet valve the opening should be during one complete stroke of the piston and therefore while the cam is rotating through an angle of 90 degrees. The outer curve is constructed with a radius equal to that of the circle o x y plus the lift of the valve or the distance d. The circle of the inner portion of the cam should next be described and be small enough to allow the cam roller to clear the cam when the valve is closed, in order that the spring may have full play to hold the valve firmly on its seat. The two straight lines ry and sx are then drawn tangent to the inner circle of the cam and so that they will pass through the points x and y. Rounding the corners at r and s completes the cam outline. In case the valve is operated by a lever the distance d must, of course, be made equal to the movement of that end of the lever which carries the roller, provided always that the valve is given the proper amount of lift.

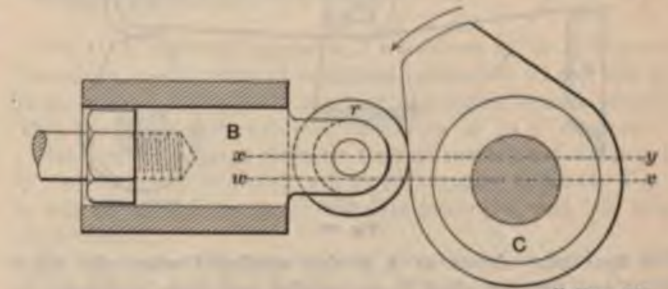


Fig. 30.

The motion of the roller which bears upon the cam is transmitted to the valve stem in various ways. In Fig. 30 the most simple method is shown in which the roller r is placed in a fork on the block B, and the end of the valve stem is rigidly attached to the block as shown. In this case the center line of the valve stem and roller denoted in the figure xy should be on that side of the line wv—passing through the center of the cam shaft and parallel to xy—that the eccentric portion of the cam is located upon when the valve is being opened. Should it be desired that the engine will run in either direction the lines xy and wv should coincide. The objection to the latter arrangement is that it is liable to bind at the moment of opening the valve and thus cause undue friction.

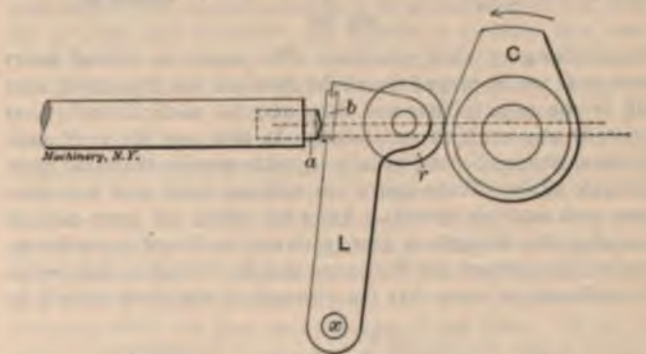


Fig. 31.

In Fig. 31 the roller is carried by the lever L and the thrust of the cam is transmitted to the valve stem through the lever. The pieces a and b are hardened steel and are employed to prevent undue wear of the parts. The center of gravity of the lever L should always be placed at a sufficient distance to the right of the fulcrum x to cause the lever to fall toward the cam at all positions of the valve-stem. Fig. 32 shows an arrangement in which the fulcrum x is between the cam and the valve stem. This is a very good arrangement for transmitting the motion of the cam through a considerable distance and is much used by gas engine builders. It is open to the objection that the inertia of the moving parts may become so great with long levers and at high speeds as to perceptibly retard the opening of the valve. In order to prevent the noise due to the cam striking the roller, the arrangement shown in Fig. 33 has been employed and is the subject of a recent English patent. The lever is supplied with the movable tongue t pivoted at p and between the end of the lever and the end of the tongue there is placed a spring m to take up the lost motion. With this device the roller is kept at all times bearing upon the face of the cam and the blow that results from the cam striking the roller is avoided. How successful this device has proven itself in practice, the writer is unable to state.

For determining the diameter of the cam shaft, the following formula represents good practice:

Let $c$ = the diameter of the cam shaft in inches;
$D$ = the diameter of the cylinder in inches;
then $c = .057\ D + .625$. (40)

Motion is transmitted to the cam shaft by reducing gears, of which the three types shown in Fig. 34 are those in general use.

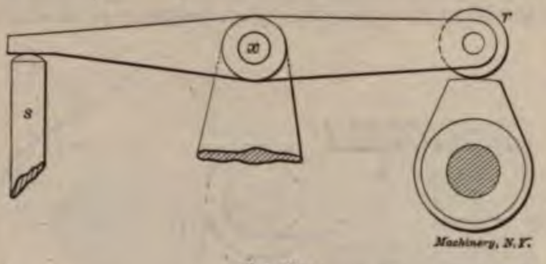


Fig. 32.

The spur gear shown at A is that employed when the crank shafts and the cam shaft S are parallel and close together. In a few engines the motion is transmitted by a train of gears when the shafts are parallel but some little distance apart. The bevel gears shown at B are employed when the shafts are at right angles to each other and when their axes lie in the same plane, so that a series of lines as pq, xy, etc., could be drawn through their axes and these lines would all lie in the same plane, or, in other words, would be laid upon the same perfectly flat surface without changing their position. The skew, or helical gears shown at C are employed for shafts that do not have their axes lying in the same plane, and they may be used, if desired, at practically any angle to each other. In this case the gear upon the cam shaft may be, and usually is, made smaller than that upon the crank shaft. These gears are nothing more nor less than screws with multiple threads. Rules for laying out gears and for calculating the strength of gear teeth may be found in books devoted to that subject and they need not be treated in this series. It is sufficient to state that the strength of the teeth should be computed upon the basis of a pressure of at least 45 pounds upon the largest exposed surface of the exhaust valve, and ample allowance of strength made for sudden movement. The writer would advise the inexperienced designer to try at all times to keep the valve-operating devices as simple as possible. Do not have a separate cam shaft for each valve and for the igniter as well. One shaft is sufficient for every purpose, and for a multiple cylinder engine, wherein the cylinders are parallel and upon one side of the crank shaft, it is nearly always feasible to operate every valve, pump, or other device upon the engine, from one shaft. Aim at simplicity and the fewest number of parts admissible for the effective working of the engine. More gas engines have been relegated to the scrap heap for neglect of this point than from any other cause. It is strange, but true, that the greatest offenders in this direction have been the designers of automobile engines. They have in many instances made themselves the laughing stock of the practical gas engine designer. There is probably not a purpose for which the gas engine is employed in which the simplicity of the motor is more to be desired.

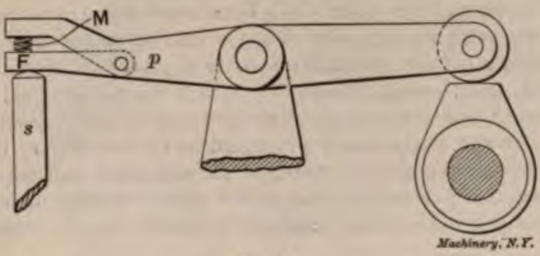


Fig. 33.

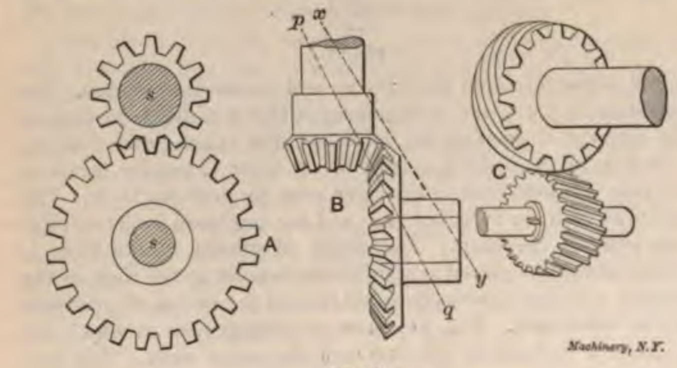


Fig. 34.

Two general methods of controlling the speed of a gas engine are in use. In one the impulses of the engine are cut out from time to time according to the requirements of the service. This method of governing was probably the first in use and is known as the hit-and-miss method. In the other, the engine receives an impulse at every cycle, the speed being controlled by varying the strength of the impulse. For want of a better term the writer has called this the variable impulse method. Each of these general methods may be subdivided, the first into four and the second into three subheads.

### Hit-and-Miss.

1. Holding the gas valve closed during the idle strokes, during which the piston draws into the cylinder a charge of pure air which is compressed and expanded.

2. Holding the exhaust valve either open or closed. When the exhaust valve is held open, the inlet valve is usually held closed by a catch which interferes with its opening, this method being nearly always used upon engines employing a suction inlet. When the exhaust valve is held closed the products of combustion are retained in the cylinder and are alternately expanded and contracted until the speed of the engine falls and the governor allows the exhaust valve to be opened again.

3. Cutting off the current from the igniter. This method is used with an engine having an automatic exhaust valve which opens only by the pressure of the exhaust operating an auxiliary valve as the gases escape through an auxiliary exhaust port. The charge is alternately compressed and expanded during the idle strokes.

4. Stopping the action of the cam shaft, and in this manner stopping the entire valve mechanism of the engine. The shaft is usually thrown out of gear with the governing clutch at such a time as will allow the exhaust valve to remain open during the idle strokes.

### Variable Impulse.

5. Partial stoppage of the supply of gas. The amount of gas admitted to the cylinder is gradually reduced until the limit is reached beyond which the mixture would be too weak to ignite. At this point the supply of gas is entirely cut off and the engine is operating after method 1. There is also a limit at which the mixture becomes too rich to ignite, and this point represents the maximum power of the engine.

6. Throttling the charge. The proportions of the mixture remain constant at all times when this method is employed. Regulation is obtained by reducing the quantity of the mixture which enters the cylinder by choking the passage through which the charge must pass.

7. Varying the lead of the ignition. This method is, of course, suitable only to such engines as employ an electric igniter, although it might possibly be used with other forms of igniters in which a timing valve is employed. The ignition is said to have lead when the charge is fired before the compression stroke is completed. To distinguish it from late ignition it is quite often called positive lead. When the ignition is late, the lead of the spark is said to be negative. The later the spark, the less will be the mean effective pressure in the engine cylinder, so that the later the ignition, the slower the engine will run under a constant load.

The best economy of fuel is undoubtedly obtained by means of the hit-and-miss system of regulation. There is little choice between the several methods, each of which has its good and bad points, but they all operate about equally well. Of the variable impulse methods, No. 5 gives the best fuel economy. Method 7 gives the poorest results in fuel economy and is used only when economy is a consideration second to simplicity of operation and effectiveness. Throttling the charge gives the best results in regulation with a reasonable fuel economy.

type of governor in use upon a steam engine has been one time or other in connection with a gas engine, to- ith several types that have been designed expressly for a gas engine. As gas engine governors are most thor- lescribed in the various books that have been written subject, probably having received more than their just e of space, the writer will not weary the reader of these with repetitions of these descriptions, but will confine o giving a few general rules for the guidance of the de-

nber that all governors should be adjustable, so that the the engine may be altered at will by changing the ten- he governor springs. If the adjustment can be made while ne is running, it will, probably, be found a great conven- The governor should be sufficiently powerful to operate ianism without waste of time. Always try to give the gov- little work to do as is practical, and in order that the r shall be sensitive, it should operate the mechanism with llest possible amount of movement on the part of the r weights or balls. Make the number of joints in the sm as few as possible, in order to avoid lost motion ould interfere with the sensitive action of the regulating Do not have the governor in a vertical engine catch stem and hold it, as the valve will drop when the gov- leases, and pounding will result.

* * *

## DARD PUNCHES FOR IRON AND STEEL.

I. P. Richards.

rmity of construction in all kinds of machinery is very both for the manufacturer and for those making repairs me; therefore any one who helps to bring about a correct makes labor easy and lightens the burdens of life.

this end in view, I have tried to bear my humble part by ing a standard for the common sizes of punches for g iron and steel.

g while in charge of the screw department of the Whitin Works, we were making square and hexagon nuts, and it was a great expense to keep the punches in order. ke a good many of the small punches, and when broken ks were too short to be drawn out again, so that they no use except for the scrap heap. It required much labor l to keep the punches in working order, and naturally to get along with as little work as possible, I conceived of making the cutting part of the punch separate from ling stock, forming a bevelled head on the punch and it to the stock by a screw coupling. After this arrange- found it very convenient to keep punches on hand, and it a great saving of steel and labor.

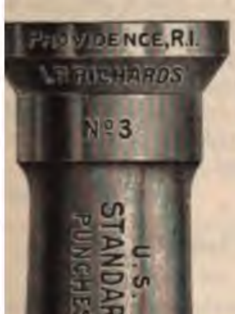


Fig. 1.

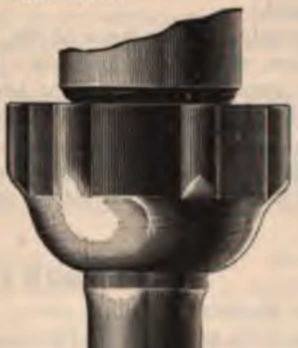


Fig. 2.

utting out nuts and washers, I made a hole entirely the punch and inserted a movable center that could be ut for grinding the face of the punch when dull, without the temper, and also for using different sizes of centers ame punch to suit the different sizes of holes. This was le improvement in the manufacture of nuts and washers. style of punches worked so well that I determined to standard for the common sizes of nuts. In 1871 I re- o Providence, R. I., and, after making the necessary tools dard gages, commenced to supply others with punches, ere found to be an improvement on the old system. A few years ago I made a new standard expressly for riveted work, making the heads of the punches larger in diameter, thus giving them a more substantial bearing, with a new and stronger coupling, having special reference to the different sizes of rivets, bolts, etc. This is the U. S. Standard, and it has been adopted by nearly all who use punches in this country, for its economy and convenience.

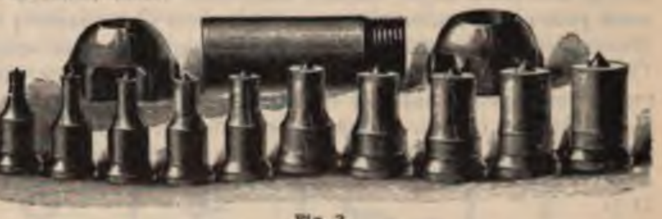


Fig. 3.

The U. S. standard includes all sizes from ⅛" to 4" diameter. There are twelve sizes of couplings, graduated to suit the different sizes of punches and numbered according to their capacity. Thus the No. 3 stock holds all sizes from ¼" to 1" diameter.

For punches of large diameter I would recommend making the face of the punch so that it will give a shearing cut, as in Fig. 1. It will go through the metal with less power and with less strain on the work.

To do good work, punches and dies should be kept in good order. Some shops use punches as long as they will go through the metal, and sometimes long after they are badly worn. This causes a severe strain on the metal, and is not a safe way, especially on boiler work where all the strength of the plate is needed. With good sharp punches there is very little strain on the metal, and not so much difference between punching and drilling as some may think.

* * *

## ENGINEERING DIFFICULTIES OF THE SOUTH AFRICAN WAR.

Capt. Zalinski, writing in "Harper's Weekly," says:

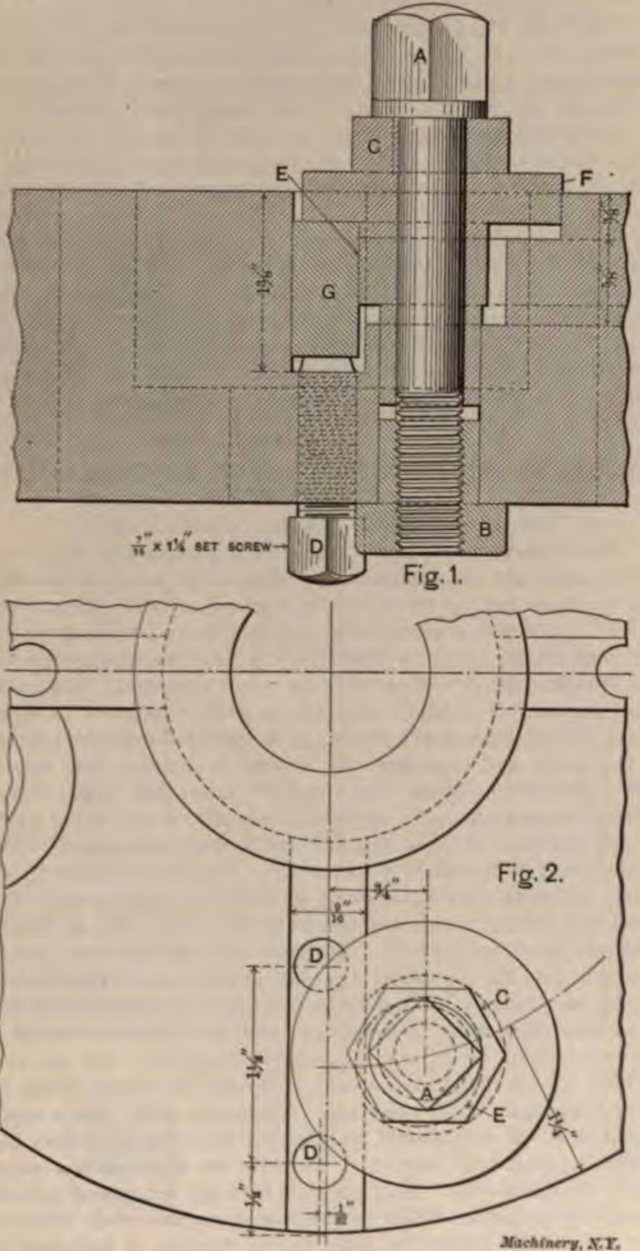
The layman cannot easily realize the vast amount of material as to food and ammunition demanded by an army in the field. A few facts and figures as to this may aid to make it more tangible. Each man requires, at a minimum, three pounds and a half of food per day. Each animal should have at least twenty pounds of food in countries where grazing is not abundant. If we take, for purposes of estimate, only fifteen pounds required to supply each animal, leaving five pounds to be gathered from the country, by grazing and otherwise, we assume a quantity that may be considered a minimum. An army of 150,000 men would require about 50,000 animals for transportation of artillery, camp equipment, ammunition, food, hospital and medical equipment. There should not be less than 30,000 cavalry. There should not be less than 10,000 animals available at all times to supply losses. This makes a total of 90,000 animals to be fed. With this as a basis, we see that the daily demands would be for the men 525,000 pounds, and for the horses 1,350,000 pounds, or an aggregate of 1,875,000 pounds. Assuming that, besides the food, an average of 100 tons of clothing, ammunition, and other supplies would be required daily, we have an aggregate of 936 tons. Six per cent. added for inevitable losses and contingencies would bring the daily aggregate up to 1,000 tons. Assuming, again, that a supply of at least 120 days should be provided for at the secondary base before operations commence, we have an accumulation necessary of 120,000 tons. With ten tons load per car, 12,000 carloads would be required. While this amount is accumulating, sufficient, in addition, to supply the army during the time of bringing this quantity to the front, would also have to be provided, so that no less than 15,000 carloads of ten tons each would be safe to assume as sufficing for the purpose. With railroads passing through the mountainous regions of South Africa, very heavy grades would have to be overcome, and high speed is impossible. An average rate, therefore, of only ten miles an hour would be counted upon, and they would require at least four days from Cape Town to Bloemfontein, allowing for unavoidable delays. The other roads could be traversed in from two to three days from sea to the places selected as secondary bases. It is not likely that more than 400 cars could be despatched daily on all the available roads, if sufficient numbers of cars and engines were at hand to commence the work. The traffic must be so managed as to permit the free return of empty cars. This would mean an initial supply of at least 3,000 cars, and no less than 100 engines.

# LETTERS UPON PRACTICAL SUBJECTS.

## NOVEL TURRET TOOL-HOLDER.

*Editor* MACHINERY:

Thinking it possible that the device represented by the enclosed blue-print might contain sufficiently novel features to merit your consideration, and prove of interest to the readers of MACHINERY, I beg to offer the following explanation of same. The device here shown is especially adapted to use on carriage turrets, for holding ordinary flat tools, and while it holds the tool G firmly in place, does away with the necessity of special tools to fit the slot. The bolt A which is tapped into the hardened bushing B binds the tool firmly on to the adjusting screws D D.



Turret Tool-holder.

The hardened bushing C is milled at the top, for a hexagon wrench, and has an eccentric at the point E. This serves to bind the tool sideways. The turret is counterbored at F to receive the shoulder on C, thus preventing the bushing from tipping off sideways.

Dexter, Me. W. L. FAY.

* * *

## RADIATING SURFACE FOR STEAM HEATING.

*Editor* MACHINERY:

In a certain large building there are two rooms similar in design, but while it is an easy matter to heat one of them, it is impossible to heat the other enough to make it comfortable in very cold weather. On account of their resemblance, the results obtained in practice are of interest, because it shows it to be difficult or impossible to lay down rules for designing steam-heating apparatus that will apply to all cases, as much must be left to the judgment of the designing engineer. Furthermore, it shows that even an expert may make a mistake along this line, for the building mentioned was designed by a prominent and reputable architect in the city where he is located, who has done much good work there. The rooms referred to are located on either side of a hall that is nearly in the center of the building, and both extend from said hall to the brick walls of the structure, in which are the usual windows. Both of them are bounded on one end by a large room extending across the whole building, and are separated from it and from the hall between them by partitions of matched sheathing, while a brick wall without windows forms the boundary on the other end of both. Beneath them is one large room, so that they are benefited alike by the heat from below, and the conditions above are precisely the same. They are heated by 1¼-inch pipes, located on their sides near the floor and are therefore on an equal footing in this respect. I shall refer to these rooms by numbers in order to make some interesting comparisons, calling the larger No. 1 and the smaller No. 2.

No. 1 is 61 feet long, 18 feet wide and 12 feet 4 inches high, containing 13,452 cubic feet of space. There are 8 windows, 3 feet 9 inches by 8 feet 6 inches, making 255 square feet of glass surface. The pipes in it contain 183.6 square feet of radiating surface. This shows that each square foot of radiating surface is expected to heat 73.75 cubic feet of space, that there are 1.39 square feet of glass for each square foot of radiating surface, and one square foot of glass for each 52.75 cubic feet of space. No. 2 is 42 feet long, 12 feet 9 inches wide and 12 feet 4 inches high, containing 6,604 cubic feet of space. There are 8 windows, 2 feet 9 inches by 6 feet 8 inches, making 146.4 square feet of glass surface. The pipes in it contain 152.76 square feet of radiating surface. This shows that each square foot of radiating surface is expected to heat 43.23 cubic feet of space, that there are .958 square feet of glass for each square foot of radiating surface, and one square foot of glass for each 45.11 cubic feet of space.

When these figures are taken into consideration it may be surprising to find that No. 1 is easily heated and No. 2 is often too cold to be occupied; for the conditions, so far as I have stated them, are nearly all in favor of No. 2, the only exception being the smaller amount of glass surface, compared with the cubical contents in No. 1, and even this difference is very small, so that steam fitters, after viewing the premises and having an opportunity to consider all of the conditions, claim that No. 2 is well equipped.

The only point in favor of No. 1 is that it gets the benefit of sunshine, while No. 2 does not. This appears to have been entirely ignored when the plant and building were designed, although it proved to be of much importance in actual service, so that after several years of trouble from lack of heat, 78 square feet of radiating surface has been added to No. 2, making it sufficient for the coldest weather in that locality.

W. H. WAKEMAN.

* * *

## A LARGE PLANER.

*Editor* MACHINERY:

One of the largest, if not the largest, planers to be found in this country is located at the Boston Navy Yard in the department of steam engineering. The machine was designed by Seth Wilmarth and was built in the shops at the Navy Yard under his supervision in the year 1866. It will plane a surface 18 x 30 feet at one setting, and, with the cross rail at its highest point, will take work 13 feet high. The tool head is made in the form of an angle plate with relieving blocks and tool posts for tools to cut either parallel to the planer ways or at right angles to this direction. The latter cut is made by throwing out of operation the platen drive and driving the tool head back and forth upon the cross rail by means of the usual cross feed screw and a pair of independent clutch pulleys. By the aid of this arrangement, a tool head on the side frames, and slow feed motions for either the cross rail or platen—it is possible to plane top, sides and ends of a block at one setting. The cross rail carries also a boring rig for holes either vertical or at a small angle. The bed

e up of nine separate castings, two sides and seven cross
Its total weight is about 110 tons. Its length is 40',
5' 6", distance between centers of V rails 12'. The bear-
face of each V is 18" wide. The planer sides are of a
hat fanciful pattern, such as was prevalent at the time that
ichine was built. Each side consists of a top and base,
pieces, and weighs about 20 tons. The cross connection
top weighs about 10 tons. The platen is 12' long by 16'
two 6' sections. Its weight is 22 tons. It is driven by a
w, a square double thread of 3" pitch working in a com-
n split nut 3' 6" long. The screw in turn is driven by
ars from a shaft carrying two 4-foot clutch pulleys with
and with crossed belts. The cross rail is 22' 8" long, 4'
and at the center about 4' thick and weighs 20 tons. It
orted by two 3" screws, with quick and slow drives for ad-
or feeding. The tool block is driven by a screw similar
platen drive only it is 5" diameter and 2" pitch. The
s driven by bevel gears from a vertical splined shaft to
ither feed or cutting speeds can be given. The tool block
earing 5' 6" long on the cross rail and some idea of its
y be obtained when the relieving block alone weighs over
nds. Although this machine is some 34 years old, there
ny points about it which would do credit to a modern
It is at present in process of removal to new founda-
here it is expected it will in the future do as good work
s in the past.

W. G. R.

* * *

## URIOUS METHOD OF KEEPING TOOLS.

MACHINERY:

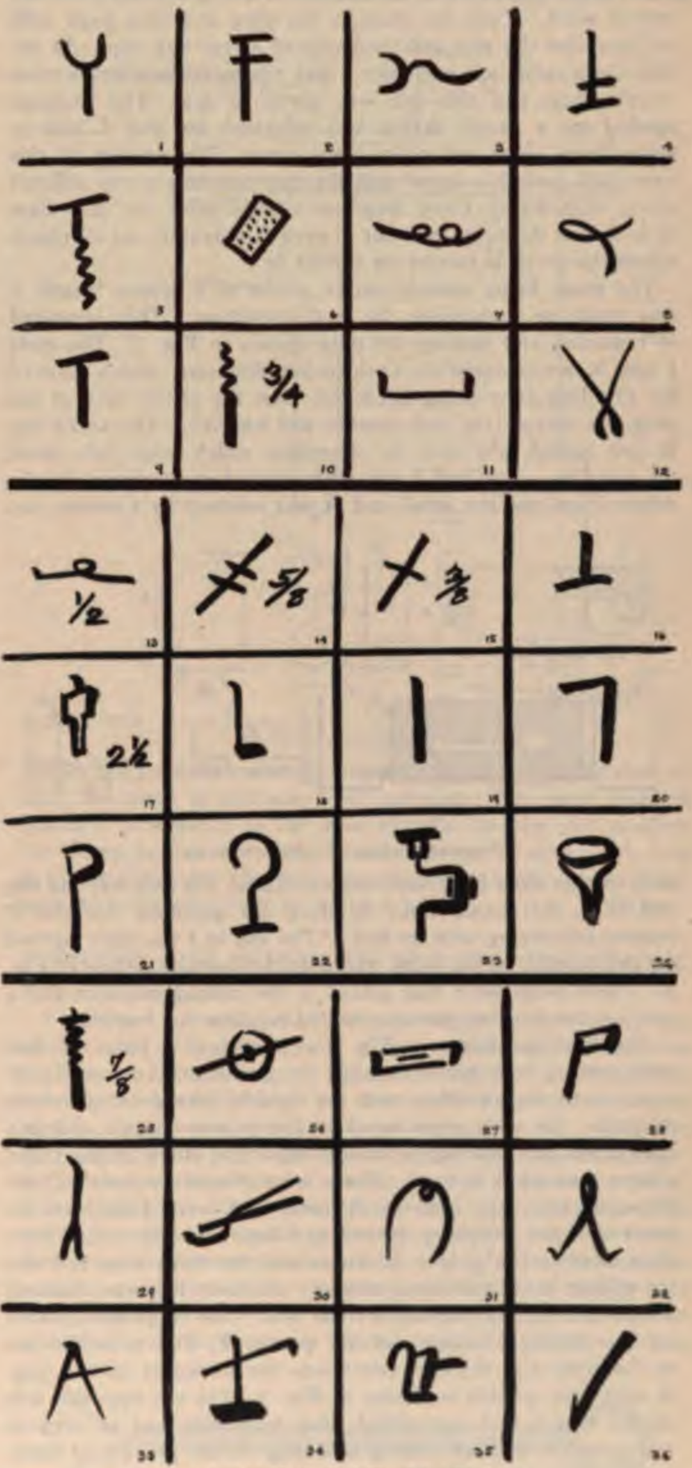
sight of the annexed sketches will surely make many
smile and wonder if they are not carried back to the
times of Egypt, many centuries ago, with her hieroglyphs,
ood nowadays by only very few mortals. But such is not
, they are simply an illustration of the way the Annamese
per of Marty & d'Abbadie's shop, in Haiphong-Tonkin,
ack of the material entrusted to his care, and this, to the
atisfaction of his employers.

first describe the toolkeeping board. It is just an ordi-
ctangular blackboard, 18" in height by 30" in length, di-
50 spaces, each carrying a small nail on top to hook on
of workmen borrowing tools. Each man receives five
tags, made of zinc and ¾" square, stamped with his shop
, so that he may borrow several tools at a time. Once
delivered, the toolkeeper takes his chalk and scribbles a
and dashes, under the man's number, which are rubbed
n the tool has been brought back, and there you are.
f the sketches are easily understood by everybody, such
of brace, the pipe cutter or the surface gage, but the
American machinist would be at a loss to find out that
eans an oil lamp and No. 15 the ⅜" reamer.

must bear in mind, these are not Chinese or Annamese
rs, but simply signs invented by our toolkeeper for his
venience. Brass or zinc tags, as used in certain Ameri-
ps, get lost through carelessness or theft of the helpers
fitters coming into the room, whilst with a bit of chalk
he is never amiss.

now explain the meaning of these hieroglyphs: No. 1
ts an ordinary open end wrench; No 2 is a monkey
with screw hand and No. 3 a nut wrench with screw jaw,
England a shifting spanner; No. 4 shows a key wrench
w propeller nuts; No. 5 stands for wood boring bit; No.
the letters and figures; No. 7 is supposed to be a double-
wrench for taps and reamers, while No. 8, which I men-
efore, represents an oil lamp, for all around use in the
o. 9 is a drill ratchet and No. 10 a Morse patent twist
ood saw is meant by No. 11, while No. 12 shows plainly
a pair of plyers; Nos. 13, 14 and 15 are, respectively, the
the ⅝" tap and the ⅜" reamer; No. 16 is the sledge
; No. 17 explains itself, it means a 2½" tube expander,
18 a soldering iron. No use to say that No. 19 is a
edge and No. 20, a "crooked edge," as the Chinese call it,
e a square; No. 21 represents a hack-saw, and No. 22, a
ter. Every one understands No. 23, whilst No. 24 is a
l. No. 25 is a ⅞" wood bit to fit brace No. 23. No. 26
ou the small circular saw for cutting metal in a lathe.
rokes of the brush have made a spirit level of No. 27. No. 28 is a wood axe, No. 29 a crowbar and No. 30 a pair of pipe tongs. A set of 24" calipers and dividers is represented by Nos. 31, 32 and 33. It is plainly seen that No. 34 is a surface gage, but No. 35 needs a little attention to understand that a soldering lamp is meant by it. To conclude the list, No. 36 is a 24" cape chisel.

The reader will notice that these sketches, as simple as can be thought of, and made with a Chinese brush and ink, represent very well what they stand for, excepting three or four in the whole series. Some of them one would take for Chinese characters, but for the fact of there being no names in either the Chinese or the Annamese language to call most of these tools by, the former using English impressions and the latter French ones. For instance, a "monkey wrench" is called in Chinese "shiftspannah" and in Annamese "laclemolette," both words being "pidgin," one for "shifting spanner" the other for "La Clef a molette."



Annamese Method of Checking Tools.

In fact, it is a kind of shorthand, which is certainly very curious and the invention of which is much to be admired in a man, who of his own idea, has made up such an ingenious system of toolkeeping in a country where, ten years ago, they had not the least idea of what a machine shop was, and would never think there might be a difference between a tap and a screw or a monkey wrench and a hammer. EDWARD C. CHODZKO.

Haiphong-Tonkin, Indo-China.

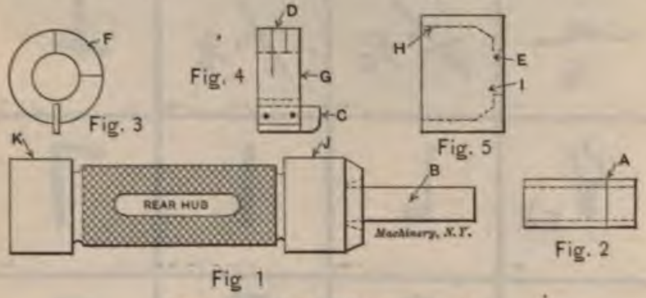
* * *

## GAGES FOR BICYCLE WORK.

*Editor* MACHINERY:

The art of manufacturing plugs and ring gages has become a science so I do not intend to deal with standard gages, but to speak of the gages used on a bicycle. It requires as much skill to make these as the standard gages—where they make a business of manufacturing that class of tools—simply because a bicycle shop as a rule, has not a tool room equipped for this sort of work. Take for example the plug and ring gage used to determine the size and thickness of a rear-hub cup. At the time these came into existence I was employed in a well-known bicycle shop and this job was given to me. The foreman handed me a pencil sketch and informed me that I was to make three plugs and rings from same. The readers of this letter will probably agree with me that this was pretty difficult work, considering there were no special tools for this class of work and the room was not of even temperature, as all places where this work is carried on should be.

The stock being already cut in pieces of a proper length, I was ready to commence the first operation. This consisted of centering and turning the plug shown in Fig. 1. The ends J and K were turned to 1.010 inches diameter, which allowed for grinding after being hardened, then the center part of the plug was turned .125 inch smaller and knurled. The small end B was turned .385 inch in diameter, which also left stock for grinding. The end J was then tapered in as shown by the dotted lines, and the small end B was relieved by a recess .005 inch smaller than finish size and extending .125 inch beyond the end of J, this being done to allow for grinding the end B without interfering with the end J. The end of J was then tapered on the outside to the same angle as the bottom of cup I, Fig. 5. These plugs were then placed in the milling machine and a spot on the knurled part was milled to allow for marking.



Combination Gage for Bicycle Hubs.

The bushing shown in Fig. 2 consisted of a piece of tool steel with a hole bored through it .370 inch in diameter. It was placed on an arbor and the outside turned to .510 inch diameter, the ends were faced to the proper length and this completed the bushing for hardening. The rings, Figs. 3 and 4 were then taken in hand. These were of tool steel with a hole through them .495 inch in diameter and were placed on an arbor and the periphery turned and knurled. The sides were then faced to the proper thickness and the rings were laid out for milling in the following manner: A center line was obtained and then a quarter line taken from that. The rings were placed on the milling machine and the quarter F, Fig. 3, milled out to the lines and through two-thirds the thickness of the ring. A side view of this is shown in Fig. 4. On the opposite side of the ring a slot was milled .0625 inch wide and as deep as was possible without risking breaking in the process of hardening. The blade C, Fig. 4, made of sheet steel the proper thickness, was then finished to allow for a slight drive in the slot. After placing the blades in the rings in their respective positions, the holes for the pins that hold the blade in place were drilled out and the blades numbered to correspond with the number on the ring. They were then heated and hardened.

Now came the grinding of the parts. The plug was taken first, the end K being ground to 1.000 inch diameter, the end J was ground to 1.002 inch and the end B to .377 inch diameter. A cast iron ring was then made, the hole being bored 1.000 inch in diameter and one side being split to allow the screw in the holder where it was to be used to adjust for the wear. The plugs were then placed in a speed lathe and, with flour of emery and benzine, a finished surface was lapped on each. At the same time they were reduced to their respective sizes, K to .998 inch and J to 1.000 inch in diameter. Another ring was then made with the hole .375 inch which, being used the same as the one just described, finished the end B and also reduced it to .375 inch, its required size. The object in making K .002 inch smaller than J was to serve as a limit in the size, to which the operator was allowed. Great care had to be exercised in measuring the plugs while lapping them as this operation caused them to heat and expand. To prevent any trouble the plugs were dipped in water every time they were measured. The bushing came next, a hole being first lapped to its desired size .374 inch, after which it was placed on an arbor, the outside circumference was ground to .502 inch in diameter, then placed in the speed lathe and lapped in the same manner as the plugs, the diameter of the bushing being .500 inch. The bushing was then taken and slightly heated over a flame of gas till it had expanded, then placed on the end of plug B and as it grew cold it contracted and fitted the plug tight. It was then covered with a thin coating of beeswax, then the plug was placed in a lathe and a sharp knife-shaped tool was placed in the tool-post and the line A, Fig. 2, was scratched around the bushing, great care being taken to have the line as fine as possible and to be sure that the tool had penetrated the beeswax to the surface of the plug. A strong solution of acids was then brought into use and the line was etched into the bushing, the beeswax being removed by slightly heating and wiping with waste. Now came the rings. The hole G, Fig. 4, was etched and the blade C, Fig. 4, was fitted and pinned into place.

Fig. 5 represents a rear hub cup when it is placed on the plug. The hole E should fit the bushing, Fig. 2. The hole H should fit the end of plug J which bottoms on surface I and the other end of the cup must be the same length as J. The cup now being in position on the plug, the ring was slipped on the bushing, the blade in the ring was gradually lapped on the end till the line on the bushing and that on the ring were exactly even, which showed the thickness of the bottom of the cup. The plugs and rings were now completed and turned over to the foreman.

The readers of this letter will readily see that this one gage did the work of four by giving the small hole, the size of the large hole, the depth inside and the thickness of the bottom. These plugs have been used successfully and are giving the best of satisfaction. A. F. NOTROH.

* * *

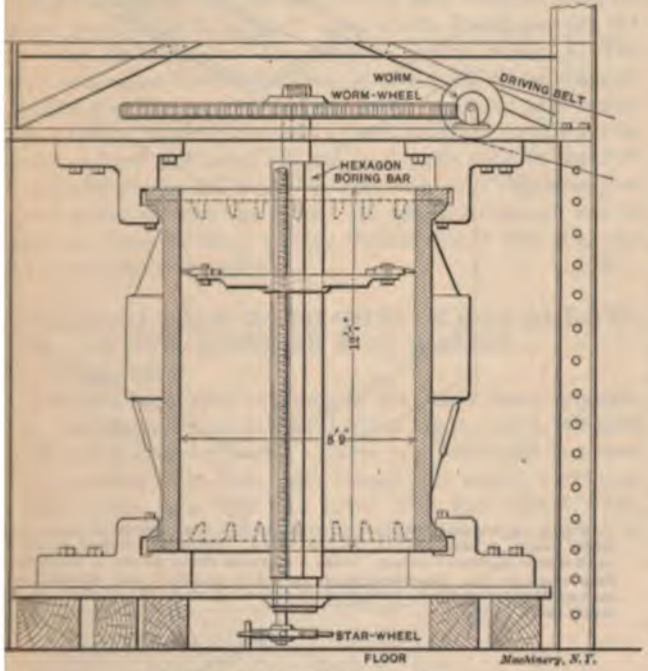
## BORING A LARGE CYLINDER.

*Editor* MACHINERY:

To those who are interested in large and heavy work I think the accompanying sketch and explanation will be interesting.

The International Power Company have a cylinder in their shops being bored out to 105 inches diameter. It is an unusually large one at any rate for their shops and required special rigging and tools. The sketch shows the cylinder as it stands now. It will be observed that it is a vertical longitudinal section view, while the large worm gear and vertical shaft upon which the cutter feeds up and down are shown in full view.

To begin with, the cylinder is 105 inches bore and 12 feet 7 inches high. It is set up on a four-arm star and clamped to it by very large clamps with bolts acting as set-screws, the whole thing being set on solid oak beams, as shown. Eight more beams support the top braces and scaffolding and there is another big four-arm star which clamps to the flange at the bottom. In the center of these two stars are bearings for the vertical boring bar, which is hexagon up to within a short space of the bearings. On this bar are two arms standing opposite each other and in one piece, having a hexagonal hole which slides up and down the bar. The screw shown in the sketch is the feed screw which is set just below the face of the bar so as to make it eccentric with the axis of the bar. At the bottom this screw has a six-pointed star (a common wheel with six studs or fins in it) which strikes a small post driven in the floor with one of its pins. It will be readily seen that the feed screw, being off the center of the upright bar, will strike the post and as the bar is turning, it hold the feed star until the engaged pin can pass. The feed is thus fed one-sixth of the pitch of the feed screw for each olution. The feed screw works in a nut in the boring arm then at the top works in a box inside the end of the hexagon . The boring arm has two pieces of steel forging bolted to extreme ends; these pieces hold the two tools, which are mon planer tools.



Method of Boring Large Cylinder.

he cutters make one revolution in two minutes and ten sec- s and it takes from four and a half to five and a half days to e one cut (roughing) and about half the time for a finishing I may say that the boring arm has to be raised after a cut and as it feeds down.

Louis A. Salmon.

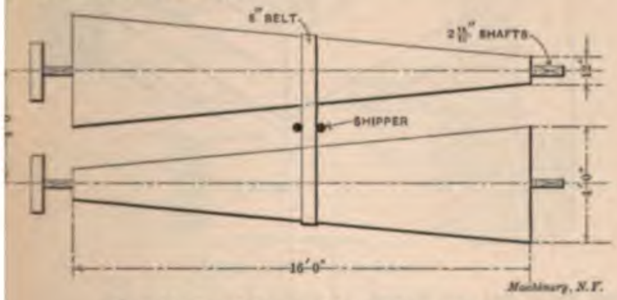
rovidence, R. I.

* * *

## VARIABLE SPEED DEVICE.

or Machinery:

uring a conversation with an acquaintance, a few years ago, poke of a factory in which variable speed cones were used to rge extent and mentioned one in particular which is the est known to the writer.



Variable Speed Cones of Large Dimensions.

he arrangement is shown in the accompanying sketch. The eys are made of properly beveled wood segments about 2½" k and a little over 16 feet long, bolted to heads at the ends, tied throughout the length by U-bolts which pass around shaft and secure adjacent segments. The nuts were counter- k into the wood and wooden plugs driven in before the pul- were turned. This style of pulley has been in use at this ory for several years and has given good service.

he device shown in accompanying sketch transmits about 15 P. maximum. The driving pulley runs at 150 R. P. M. and driven pulley from 38 to 600 R. P. M.

Wm. Sangster.

maica Plain, Mass.

* * *

## HACK-SAW GUIDES.

or Machinery:

ny one who has ever had anything to do with a power hack- knows how hard it is to get one to saw straight. The fixture shown obviates this difficulty. By means of it I have seen pieces of tool steel four inches in diameter sawn off, and it was done as well as in a lathe or cutting-off machine; and better than in either of these machines when run by a mechanic who grinds more clearance on one side of his tool than on another.

Fig. 1 shows the rig in position on the saw frame. There are two guides made in halves, as shown in the detail. The front guide is made adjustable and moves back and forth in the slot A to suit the work. The nut on the end of the bolt in Fig. 2 has a tongue that just fits the slot so as to keep it from turning when the guide is adjusted to the work and the bolt tightened. The back guide is like the front, with the exception that it has no nut on the bolt and is fastened to the saw by means of a hole tapped into the bed. The slot B is made to fit a new saw blade. Both guides are hardened, and the edges of the slots rounded over to keep the teeth of the saw from catching. The back guide is placed a little ahead of the front edge of the vise jaw to allow the clamp for the saw blade to clear during its stroke. A strip is then put between the work and the jaw to bring the work out even with the front edge of the back guide.

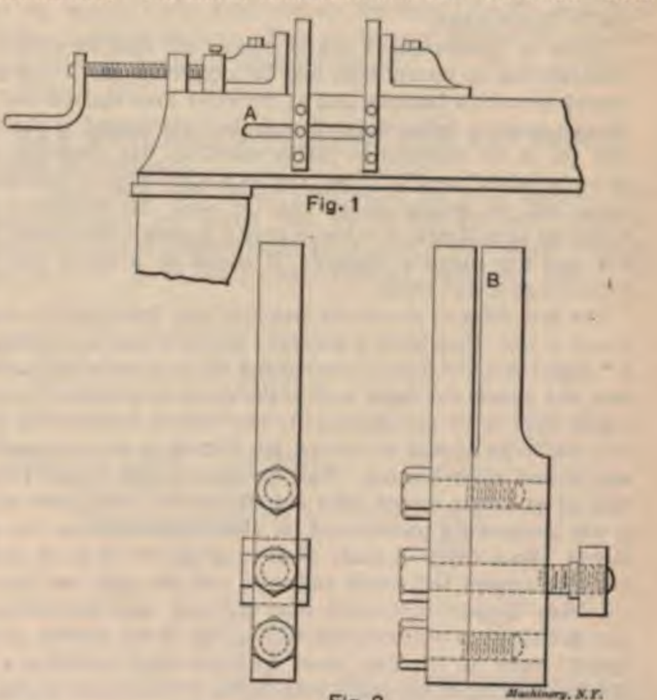


Fig. 1

Fig. 2

An Aid to Accurate Sawing.

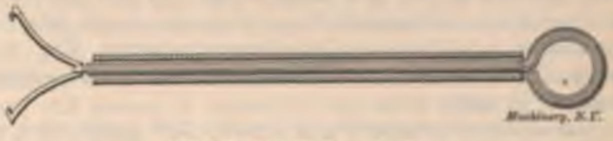
Win.

* * *

## FISHING FOR WIRES IN ELECTRICAL WORK.

*Editor* Machinery:

I have had occasion lately to do considerable work in the way of concealed wiring for burglar alarm circuits, etc. Most of the readers of Machinery are doubtless familiar with the old-fashioned way of "fishing" for wires behind partitions, etc., by means of a wire rod with a hook formed on the end. Now this is a very slow and tedious process, and it is well named "fishing," for it takes quite a while before you succeed in getting a "bite." "Necessity being the mother of invention," I devised a tool by which the operation can be performed with no trouble whatever. For instance, suppose you wished to run a wire from an upstairs room to a window or door connection below; you simply bore a three-eighths inch hole at the top of the baseboard through the plastering (or wherever it is desired to drop the line) and drop your small chain attached to a string and then bore a three-eighths inch hole through the window or door casing where the connection is to be made. Now insert the tube with the "fingers" drawn back into the tube until the whole thing has been pushed through an inch or two. Then push on the wire which opens the fingers and push the tube further into the hole until you have passed the point where the string has been dropped; then pull



"Fish-hook" for Electric Wires.

the wire and the string and chain will be drawn into the tube and the whole apparatus can then be withdrawn.

This device can be used in all places where it is necessary to do concealed wiring.

The accompanying sketch very clearly illustrates the device. The tube should be about 5/16 inches outside diameter so as to easily enter a ⅜-inch hole. The wire fingers should be made of steel music wire and the wire rod for drawing the same into the tube can be made from galvanized wire, about No. 9 or 10.
CHAS. G. TAYLOR.

Burlingame, Kan.

* * *

## MOVING AN OIL TANK.

*Editor* MACHINERY:

While at Dunkerque I ran across an oil tank 25 meters in diameter and 10 meters high (say 82 x 33 feet), which had been moved 50 meters laterally and at the same time rotated 180° on its axis so as to bring the outlet on the west instead of the east side (or as the engineer in charge stated it, "the discharge had to be 'oriented' west"). The tank held 4,000 tons of petroleum when full; its weight empty was 130 tons. Its thickness was from 6 to 12 millimeters = say, 0.27 to 0.53 inch. Its bottom was flat, and top rounded slightly. It rested on a beton bed 0.80 meter = 32 inches thick.

The first thing to do was to make the new beton bed in which it was to rest; then build a mortared masonry wall 0.50 meter = 20″ high above the level of the old and the new beton bed, and to ram and puddle the earth well in the space over which the tank would have to be moved laterally and turned, because the tank was not to be moved on rollers, but floated to its new position and turned while floating. The 130 tons weight (empty) on a base of 49 square meters gave a draft, for the vessel into which it was temporarily transformed, of about 0.27 meter = say 10.8 inches. So a depth of water of 40 to 45 cm. = 16 to 18 inches over the cement bed would suffice to tow the craft and turn it.

I have already mentioned that the tank was flat-bottomed, and this shape is not favorable to floating off the bottom of the "pond" made for it. But "there are other ways of killing a cat besides choking it to death with butter." The little matter of flotation was started by pumping air into the tank until the bottom bulged downwards and let the water under it. It was then an easy matter for men with ropes to haul and turn the tank. Piles previously placed in position limited the motion and aided in leaving the tank exactly where it was wanted. The internal air pressure was kept up until the tank was in its new place, to prevent the upward water-pressure from dishing the bottom upwards; this upward pressure naturally amounted to about 0.26 ton per square meter, or say 52 lbs. per square foot. Naturally, a calm day was chosen for the "flitting," as the Scotch call a moving.

The operation was successful and had the merit of being not only original, but economical, which is more than can be said of much gasometer and oil tank work.

ROBERT GRIMSHAW.

* * *

## DROP HAMMER FOUNDATIONS.

*Editor* MACHINERY:

Jones wrote me asking about a foundation for his steam hammer. I sent him one or two clippings and later he wrote me that the makers of the hammer had sent him prints and he had followed them. The next time I saw my friend Smithers we talked about hammer foundations. Smithers has four or five drops, which he is running day and night. He interests me. He has ideas of his own about things. At this time he was putting down a foundation for a new 1,200 pound drop. The foundation is made as per accompanying sketch, Fig. 1. He allowed it to harden about three or four weeks before setting the hammer in place.

Just across the passageway is another 1,200 pound drop which had been put in several years ago and had cracked the base. Pending the arrival of a new one, this base was in use, heavily clamped and bolted together. He showed me the blue print of the foundation, which had been put down under this hammer and it is reproduced in Fig. 2. This was the practice of a first-class concern several years ago. Now they recommend the solid foundation as in Fig. 1. This is interesting as an example of the growth of the anvil principle.

On the next visit Smithers had both hammers in opera
The hammer with a solid foundation was coming down w
solid "chunk" which indicated that no lost energy was take

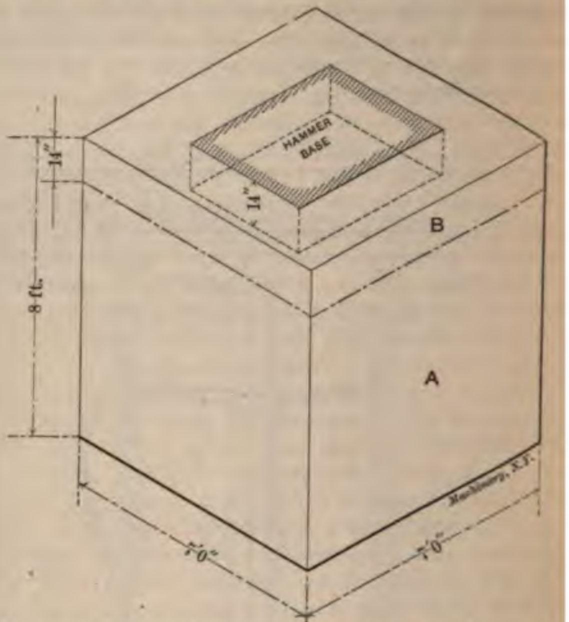


Fig. 1. A, made of concrete consisting of 1 part mortar (1 cement, 2
white sand), 3 parts 2-inch broken stone. Concrete tamped every 6
until water appeared on top. Base A allowed three weeks to harden and
dampened on top. Hammer base placed in position and cement mort
inches deep poured in to keep base in place. B made of 1 part cement, 1
white sand.

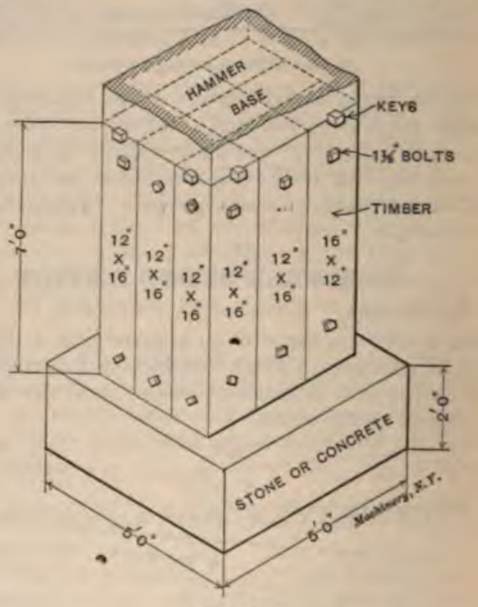


Fig. 2.

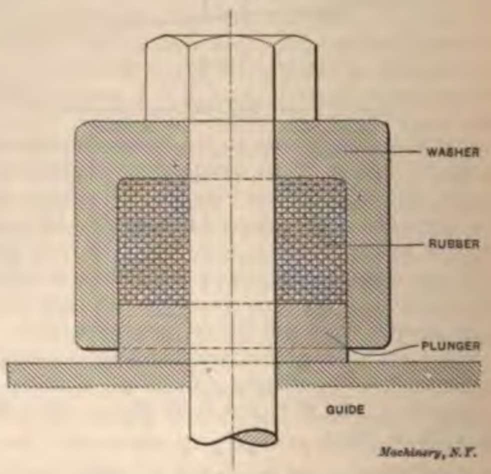


Fig. 3.

by springy or elastic foundations. The other hammer, while
ing good work, did not give out the soul-satisfying note of
new one. Then Smithers began to tell of his troubles with
bolts which hold the guides to the base. They kept breaking

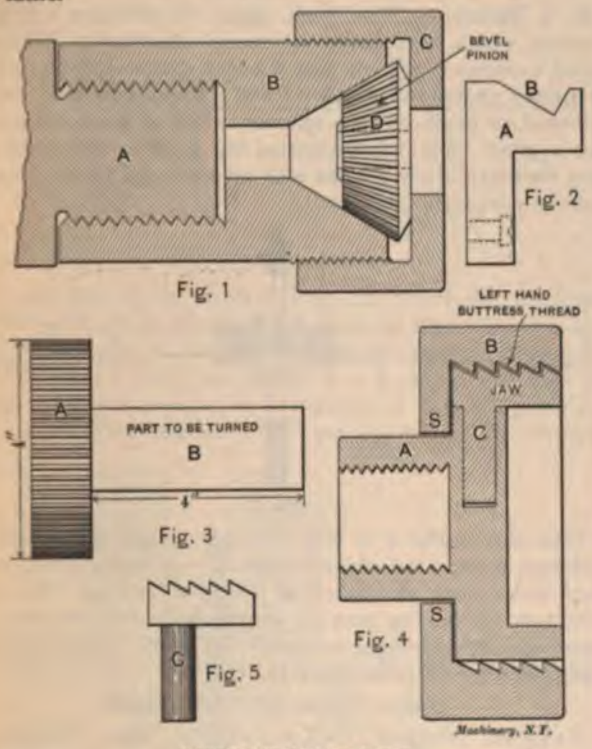
Said he had been figuring it out and had come to the conclusion that the anvil or base had to take up the energy of the blow and naturally tried to get away from it. The guides and running gear were not in so much of a hurry and held back a little. This caused a heavy stress in the bolts which had to bring them on. He called it the inertia of the parts or something like that. His remedy was to place an elastic substance between the bolt heads and guide flanges, so that no matter how hard the nuts were set up there would still be a slight give which would prevent the heavy strain on the bolts. The device is shown in Fig. 3. The counterbored washer with the plunger fitting the same prevents the rubber from being squeezed out under pressure and in fact almost makes of it an elastic fluid. One cannot ordinarily set up the bolts so hard that there will not be a slight yield in the rubber. This he thinks will stop the "snap-the-whip" business that has been going on with the bolts. He has had them on one of the smaller drops for three or four months and is fitting up the others as rapidly as possible. S.

* * *

## THREADING TAPS WITH SHRINKAGE ALLOWANCE—CHUCKS FOR GEARS.

*Editor* MACHINERY:

In the How and Why columns of the April issue, question No. 44, "Subscriber" asks how to thread a tap so that it will have the right pitch after hardening. There is a toolmaker less than a hundred miles from here, who thought he struck a scheme. He made some long taps and found they had shrunk. The screws to work in the nuts tapped by these long taps are cut in the lathe.



Chucks for Holding Gears.

To make the pitch correspond he moved the tail stock over, then set the taper attachment to correspond. To his consternation and the amusement of the machinist he only made the matter worse. If "Subscriber" will thread the tap by this plan, he may overcome the trouble caused by shrinking, as it is possible to thus obtain a slight variation from the correct lead sufficient to overcome the shrinkage.

As we have a great many small cast bevel pinions to bore out, I made some special bell chucks like those in Fig. 1. The body B screws on to the spindle A and is bored out to fit the pinion. There is a nut C that fits over this end of the chuck to screw up against the pinion and force it into the taper. These chucks more than pay for themselves in time saved in chucking. The pinion will center in the chuck very true. Perhaps a better way would be to get a three-jaw universal chuck, one of the kind with a removable jaw like the Westcott, and make a special jaw like that shown in Fig. 2; then you would need a separate set of jaws for each size of pinion. Sometimes toolmakers find it a great deal easier to make tools like these in the shop than to induce their firm to buy them, even though they may cost a little more than the ready-made. We make a little spur pinion with a cast and turned shaft like Fig. 3. Several thousand are made in a year. I found it a very easy matter to center the end of the shaft, but the other end was more of a job. A belt chuck was first made, but was found very unsatisfactory on account of the variations of the castings. Then three set screws were put in, but this proving too slow, I made a chuck as follows: The bell chuck was used for the body B, Fig. 4. A nut to fit over this and fit snug on the body at S S was also made. In this a left-hand buttress thread was cut. In addition to this, three jaws like in Fig. 5 were provided. I cut three notches in the body of the belt chuck and drilled holes for a guide on the jaws. I fastened these jaws in the body and bored the inside of them to fit the casting to be held and cut the thread on the outside to fit the thread in the nut. This works very satisfactorily, but no better than a three-jaw universal chuck. W. A. BRIGHT.

Decatur, Ill.

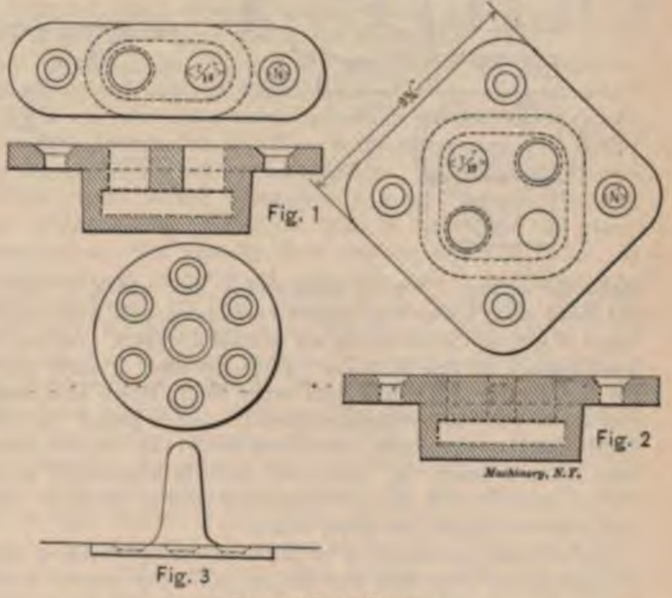
* * *

## RAP AND DRAW-PLATES FOR PATTERNS.

*Editor* MACHINERY:

I have been very much interested in your letters from practical men, but regret that we do not get more hints on wood work and pattern making. I note with interest your reply to J. T. B. in the January number, page 159; also S. M. Preston's suggestions in the March number, page 219, about draw plates. In my seventeen years' experience as pattern maker at the Terre Haute Car and Mfg. Co., of this city, I used the kinds of plates described until I found that the sand in the bottom of the hole would accumulate and the moulder would screw in his draw iron on top of it until he would either lift out the plate or burst the pattern out below it. This experience drove me to make a rap and draw plate like Fig. 1. The chamber communicates with the holes to allow the sand, when crowded from one hole, to escape to the other. One hole is tapped to draw by and the other left plain as cast to rap in. Then I found that the moulder would soon rap in the threaded hole and spoil his thread, and that I often needed a heavier plate. So I made one like Fig. 2, with the same chamber feature connecting all the holes and also protecting the pattern from the pressure of the sand under the draw-screw. This works well, but lasts only four times as long as the first, as they will soon rap in all the holes. What will men do then? Just drive their old draw spike (the greatest pattern destroyer in the foundry) deep into the pattern to draw it by and keep at it until the pattern is ruined or you catch them at it and put in a new plate. To prevent this I made a draw plate with a handle on it to rap against, so that every pattern would have a smooth handle to draw it by. See Fig. 3. This one I was persuaded to get patented, which seems to have killed it, though I have tried to push it on the market at a very low price as you see by list enclosed. It is not the purpose of this letter to advertise this little pin of mine but to add my experience to that of the many who have so kindly given us theirs.

Terre Haute, Ind. E. T. WIRES.



Rap and Draw Plates.

## SHOP KINKS.

### A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

**Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.**

### TURRET TOOL—MILLING MACHINE CHUCK.

W. F. Long, San Antonio, Tex, says: I send you the accompanying sketches of several shop devices which I will endeavor to describe in as few words as possible. Referring to Fig. 1 we have what I call a "poor man's" turret tool. This is used in the saddle of a common engine lathe by having one for each operation that is to be performed. It is small work to make the change. Fig. 2 illustrates a tool which, I believe, has more good points than others now in use, still I have never found one in any shop during my extensive travels. Among the good points of this tool are ½ the amount of steel saved; 1½ times more wear than with other tools, which also means that amount of blacksmith work saved; a much greater top rake, which makes a free cutter, and a less front rake. It will, therefore, carry a heavy cut. Steel ¾" thick is abundantly strong for any class of work on a 21" lathe, and steel of ⅞" to 1" thickness will be required for larger lathes.

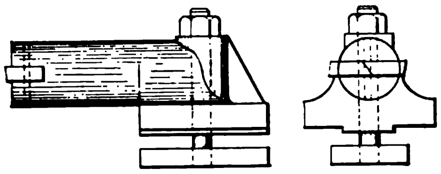


Fig. 1

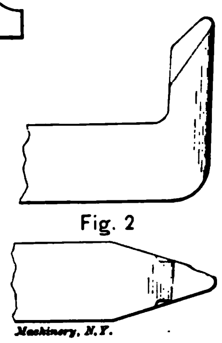


Fig. 2

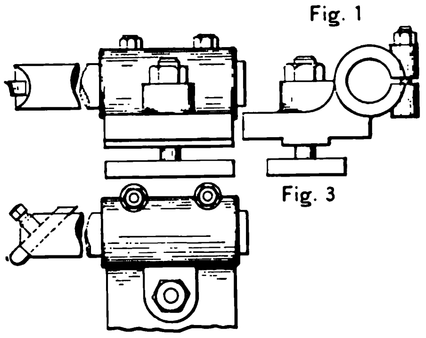


Fig. 3

Fig. 3 shows an extension boring tool which, I believe, needs no explanation other than that the tool is held in position by the friction caused by clamping the two studs in the shell. This permits the bar being revolved to get the tool to the proper position. For a 24" lathe, a bar of 1 11/16" made from shafting 24" long, will answer most requirements, as it can be adjusted to the length desired.

Fig. 4 is a device which has many good features. The pin outlined gives a good idea of what can be accomplished by its use. Although it is quite a simple job to mill such a pin, many would spend much time trying to decide the best way to hold the same. This tool is quite useful with lathe, planer, drill-press and milling machine, as its capacity is limited only by the distance between the bolts.

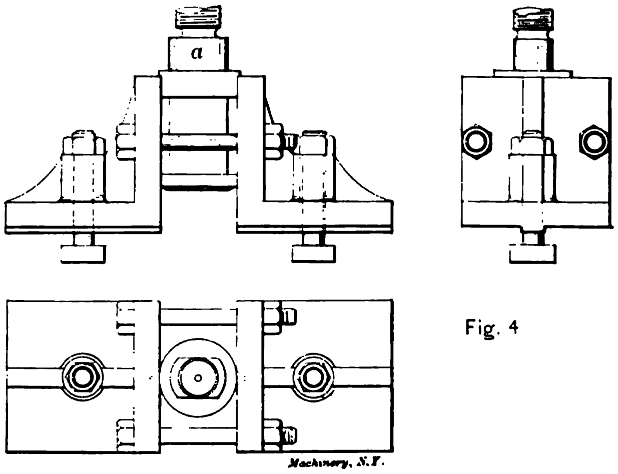


Fig. 4

### BALANCE WEIGHT FOR TURNING CRANK-SHAFTS—CENTERING DRILL.

O. A. R., Mattoon, Ill., sends in the following kinks: He says, "I had some heavy engine center cranks to turn, which, when it came to turning the wrist pins, were found so heavy that weight enough could not be put on the face-plate to balance. So I had centers made as in the sketch, Fig. 5, and clamped the weights on each end and found it much better than balancing altogether on the face-plate."

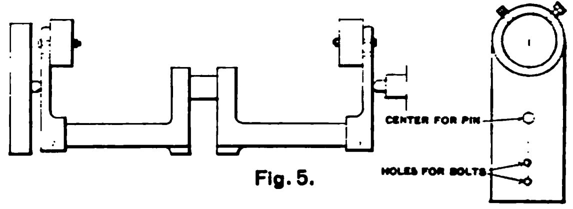


Fig. 5.

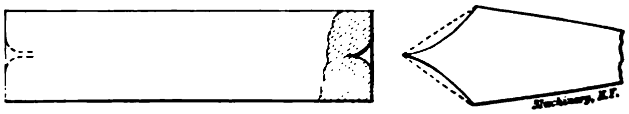


Fig. 6.

In turning a taper, where the tailstock is set over, if the center drill be ground with a concave lip, as shown in Fig. 6, it will give better results, as the work will run truer when the tailstock is changed or set to cut straight.

### TAP WRENCH.

H. J. Bachmann, New York, says: "I send you a few suggestions which have come under my observation during my varied experience. If you own a 2-inch micrometer do not let it lie around an Almond chuck. I had a brand new one once and it looked so much like the spanner, which is generally missing, that a green "machinist" inserted the anvil in the chuck hole, gave the barrel a few thumps with his hand and the drill was fast and the micrometer broken.

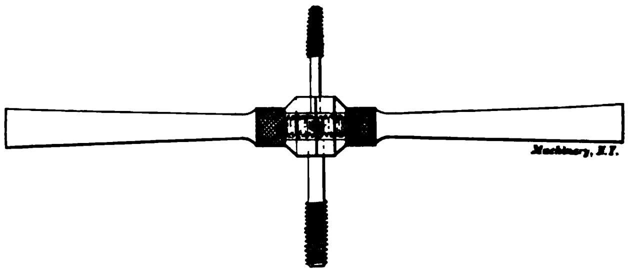


Fig. 7.

"The sketch Fig. 7 is that of a tap wrench which will hold four taps at once and which I think is very handy where several sized holes must be tapped in the same casting. The center blocks or tap holders may be accurately milled out with a 45° cutter and should be of hardened tool steel. The handles are made the same as an ordinary tap wrench."

### DRILL WITH DIVIDED POINT.

Harry M. Johnston, McKeesport, Pa., says: "Having had occasion to bore an 1" hole in a solid steel forging, I attempted to run a ¾" drill through it preparatory to boring. Everything went O. K. until the hole was drilled with the exception of about 3/16", when the drill refused to cut. Upon examination I discovered a small, very hard spot in the center of the end of the hole. I took the drill, the point of which was fractured, and ground a conical groove in the center, as shown in Fig. 8, and it cut that hard spot out easy as a pie."

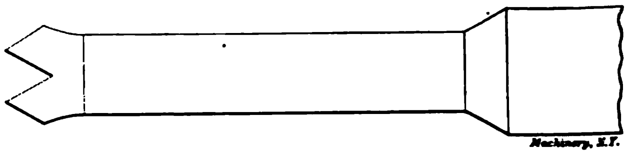


Fig. 8.

### CENTERING FORK.

J. Suess, Chicago, Ill., says: "Enclosed you will find a sketch, Fig. 9, of a fork for use in a lathe for centering large numbers of small round stock without the use of a dog or center punch, which is, consequently, a great saver of time. This fork does the driv-

and allows the use of the square center in the ordinary way. s turned to fit the lathe spindle, C is projected beyond the e of the spindle and is turned and bored to about the same el as in the sketch. B is an end view when C is milled out. hows an end view of one of the prongs or forks which are

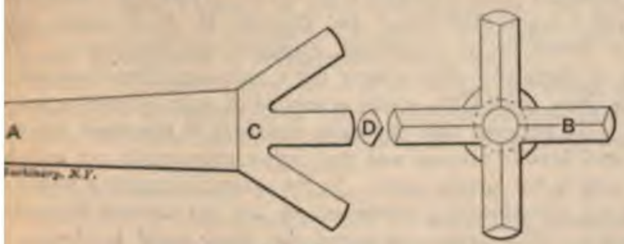


Fig. 9.

ed so that each one of the four has a sharp corner on the de for biting into the work and driving it. Those prongs ht to be twice as heavy as shown in the sketch. In using tool there is no need of stopping the lathe for placing the k in or out."

### TAPPING RIG FOR DRILL PRESS, ETC.

rank Greiner, New York, says that Fig. 11 represents a cheap e-made tapping rig attached to a drill press, and Fig. 10 a eshift substitute for a following steady-rest, for turning long k nut-taps, etc. A in Fig. 11 is the spindle of the drill press; the stationary sleeve, serving as bearing for the spindle; C C

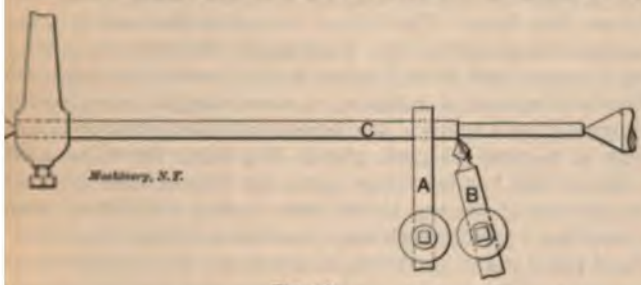


Fig. 10.

he cast iron frame, in two parts, the upper one fitted and nped to B; D D are the studs (four of them) holding C C ether; E is the machine steel shank or spindle carrying the F, G, H, I and J are gears; K is a spring tempered pin ugh E, which engages, or is engaged by L in F "going in," by M in I "backing out"; L M are also spring tempered pins

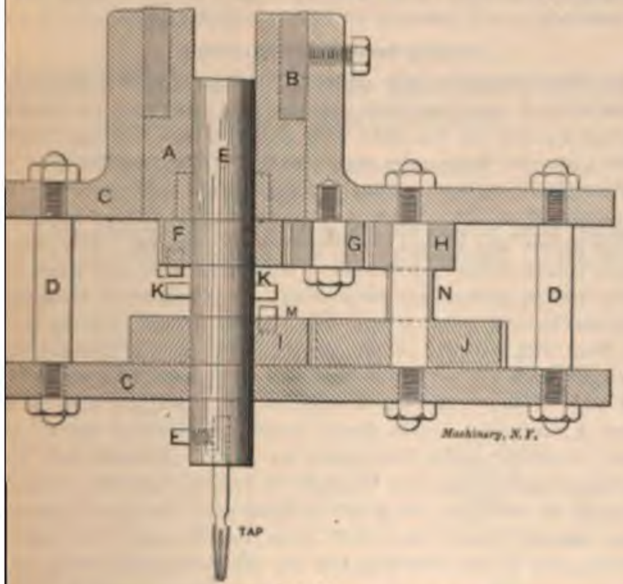


Fig. 11.

ears F and I. E, which is loose fitting in A, F and I, is ed upward, when tapping, and being engaged through L and revolves in the direction of spindle A, till the tap is through, he stop collar on top of the spindle compels L and K to disge. When "backing out," the whole attachment is forced y from the work and K is engaged by M in I, which runs in opposite direction, owing to the interposed gear G.

ig. 10 is self-explanatory. C is the stock to be turned down, A is an ordinary lathe tool put in the tool-post backward, while B is the regular diamond point tool. As will be seen, two toolposts are necessary. Tool-post No. 1 holds the steadier, which has a hole drilled through it to fit the stock snugly, while the diamond point tool occupies tool-post No. 2. It is essential to have both centers align perfectly and to center the stock carefully. This being done, the cut is "set," and plenty of oil is fed on the work. The shank may be turned down in one cut without any chattering.

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## AT THE CINCINNATI MEETING[*].

### REPORT OF THE PROCEEDINGS AT THE RECENT CONVENTION OF THE A. S. M. E.

There is no city more appropriate as a meeting place for the American Society of Mechanical Engineers than Cincinnati. It is the great machine-manufacturing center of the country, particularly in the line of machine tools, which, because of their use in machine construction, are of greater interest to a larger number of engineers than any other class of machinery. The shops of Cincinnati are for the most part new and modern and are good examples of the best practice. Cincinnati itself is the center of a large manufacturing district and is easily reached from most of the manufacturing cities of the West. As might be expected, many Western engineers and manufacturers were present who are seldom seen at the meetings in New York and other Eastern cities and thus the influence of the organization was broadened and the acquaintance of many of its members widened. On the other hand, many well known engineers who are usually present and contribute to the discussions were absent, and the discussions suffered accordingly.

With regard to the discussions it should be said that they were disappointing. Under the rules of the society the papers presented are first read by their authors, either in full or by copious extract as preferred, and then follow the discussions. When the papers are long, much time is consumed before the opportunity for discussion is reached and the main object of the meetings—that of getting together and interchanging ideas by a free discussion—is defeated. The present practice curtails the discussions, makes the meetings long and tiresome and when, as was the case at Cincinnati, the weather is warm, the members are tempted to devote more time to social matters than to the more important professional duties. All the papers are now sent to each member of the society several days before the meetings, so there is ample opportunity for all to become familiar with them without the customary reading. With this reading omitted and with more effort towards drawing out discussions from members of the society, particularly upon the more important papers, the sessions would not only be of greater interest, but the value of the published reports of the meetings would be greatly enhanced.

The first session was called to order by President Charles H. Morgan, in the convention hall of the Grand Hotel on Tuesday evening, May 15. An address of welcome was delivered by the Mayor, and in his response President Morgan impressed the fact that the chief aim of the mechanical engineer should be to render service, illustrating his point by a personal incident that happened over forty years ago. At that time Mr. Morgan was called to Cincinnati to install some machinery and as some parts had become broken in transit he went to the shop of Latta Bros. for repairs and assistance. "To these men," he said, "backed by Miles Greenwood, is due the conception, construction and introduction of the first automobile steam fire engine of America. Seeing one of these engines put out a fire made a great impression upon me, and, when it was decided to hold our spring meeting in this city, I looked forward to taking these gifted men by the hand, but I find they have both passed on. Cherish the memory of these men who did so much to make your homes and the homes and property of our country more secure from the ravages of fire, for in so doing you will encourage some young mechanics or engineers who may be hungry for recognition or appreciation." The evening closed with an informal reception and smoker.

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[*] On page 297 will be found abstracts of most of the papers read at the Cincinnati meeting, and in what follows brief mention is made only of the more interesting discussions and events that occurred during the three days of the convention.

### Wednesday Morning Session.

The first professional paper on the list was that on the value of a horse-power, by George I. Rockwood, which was here brought up for discussion a second time, this being a paper that was presented at the last New York meeting. In Mr. Rockwood's temporary absence the next paper upon "Hot Water Heating from a Central Station," by H. T. Yaryan, was taken up. In the discussion, F. N. Jewett, of Chicago, contended that storage tanks for systems of this character were not of great utility because of the enormous size required to supply heat for any considerable length of time. Fred A. Waldron advocated the vacuum system of steam heating in preference to heating by hot water and cited the system in use at the Yale and Towne works, which runs on 13 pounds absolute pressure, or 4 inches of vacuum, and all the condensation is returned to the boiler. In Mr. Yaryan's paper were given 14 reasons why the author preferred hot water to steam heating and to several of these Mr. Waldron made reply in detail, showing that the objections raised did not prove valid in the installation mentioned. William F. Mattis contributed an amusing communication in which he disputed the sweeping claim that hot water heating would be the system of the future. He said that a complete system should supply heat for cooking and for power as well as for heating and that fuel gas as a by-product of coke, natural gas and the culm heaps of the coal regions deserved recognition as future possibilities for extended heating systems. He thought gas conveyed in pipe lines might be as profitable as coal conveyed by rail. In reply to the discussion Mr. Yaryan said that he advocated storage tanks simply to take the excessive heat from the exhaust at certain times during the day when the demands for power were greater than the demands for heating. He also held that the vacuum system, while practicable for factories, was not so for heating, because of the difficulty in collecting and returning the drip. He stated also that wrought-iron pipe withstands the corroding action of hot water better than steel pipe and that distilled water, such as is obtained from the drips in a steam pipe, is very destructive in its action upon both steel and iron pipe.

The next paper was by Prof. Aldrich upon "Systems of Electric Transmission of Power," and brought out very little discussion. Such opinions as were expressed were mostly in favor of the induction motor, largely because of the small amount of care required. One speaker suggested that as many as possible visit the Bullock Electric Shops in Cincinnati, where all the machines are operated by independent direct-current motors. These motors are wired in such a way that no resistance coils are necessary for varying the speeds of the motors. There are four currents of different voltages available for each motor and any two or all of them can be combined, or the motor can run with any single one, thus giving a great variety of speeds, as a result of the different voltages that can be obtained, either singly or in combination.

"The Design of Speed Cones," by J. J. Guest, and one or two discussions upon the paper, were read by title only because of their mathematical character.

Mr. Rockwood's paper was finally considered before the close of the session, Mr. Rockwood then being present. At the last meeting of the society Mr. Rockwood introduced a resolution to the effect that a committee be appointed to investigate the question of water power privileges with a view to formulating some general principles that would enable an engineer to determine the value of a water power confiscated for public use. The council held that as both legal and commercial points were involved in such a question it was without the jurisdiction of the society, and the gist of the discussion at this meeting was upon this point. This view was supported by J. M. Smith in a written discussion. Mr. Rockwood contended that in its broad sense engineering should include as much of commercial law and practice as an engineer would ordinarily meet in his daily duties and that the subject came as much within the scope of the society's work as the subject of engine tests, which is now being considered by a committee.

### Wednesday Evening Session.

On Wednesday evening was the second session for reading and discussing papers. The first paper, by Dr. Thurston, brought out a few words of approval from Mr. Rockwood with regard to the use of separators in connection with reheaters. The second by Prof. Magruder, upon "The Gas Engine Hot Tube as an Ignition Timing Device," was simply a record of a large number of experiments and not of a character to allow discussion of importance, and the greater part of the evening was devoted to the paper by N. O. Goldsmith, upon the "Water Softening Plant of the Lorain Steel Co.," and that by M. P. Higgins upon "The Education of Machinists, Foremen and Engineers." The first of these two papers drew out a valuable letter from A. A. Cary, New York City, giving a resumé of water softening methods. He believed that chemical treatment is the most successful and flexible process and that boiler compounds are suitable for only a few special cases. In the matter of treating water to remove scale-forming elements we are far behind European practice. One writer advocated the more rapid treatment of water by using higher temperatures in the heater, which would tend to throw down more impurities in a shorter space of time. He would treat the water with soda ash only, since this will effect the precipitation of the impurities, although it will not make them insoluble. In reply to a question as to the cost of water purifying at the Lorain Steel Works, Mr. Goldsmith stated that the chemicals and labor amounted to about 2⅛ cents per 1,000 gallons and that while the plant cost 30,000 dollars, one of like capacity, to handle 1,200,000 gallons per day, could be built for 12,000 dollars.

The discussion of Mr. Higgins' paper was in general favorable to his plan for training boys to become useful workmen upon leaving school or to enter a higher technical school upon graduation as they desire. He believes in raising the level of a large number of men rather than devoting all education to raising a few to a very high plane, leaving the rest to shift for themselves. He cited the case of a boy of 14 years who has completed the grammar school course. The boy is undecided whether to go to work or to enter the high school. His father thinks he is able to support the boy four years more, but then is confronted with the idea that at the end of that time the boy will still be unable to earn his living through any preparation he may have had at school and it is this condition of affairs that Mr. Higgins wishes to change. One speaker made a strong plea for the education of the working mechanic and told of his struggles to obtain a Whitworth Scholarship in England, as an illustration of the difficulties that young mechanics who want an education often have to contend with. William Kent expressed the idea that if Mr. Higgins' half-time school should be fairly introduced to supplement the work of the technical college, it would be found a necessary adjunct of the present educational system and that its methods would become quite generally in vogue.

### Closing Session on Thursday.

Mr. Herschmann's paper upon the Automobile, although upon a new subject, contained little that any one attempted to criticize. He had worked out his plans with so much care that his conclusions appeared to be very well justified. One speaker had investigated the subject quite thoroughly and had come to the conclusion that all four wheels of an automobile should be driven by the motor and should also be used for steering. This would enable trucks to move sideways as well as forward and back in a circle, and in spite of the mechanical complication he thought a good mechanical solution possible. It was brought out by E. F. Du Brul that because of the steep grades in Cincinnati steam carriages were the only ones that had so far met with success in that city. Heavy trucking is difficult and expensive and he believed a successful steam truck would be received there with favor. Another point mentioned by E. W. Roberts was that gasolene engines can now be made to run with a wide variation of speed by changing the point of ignition of the gas in the cylinder and carriages fitted with them require only two sets of gearing, one for hill climbing and one for running on the level.

At this session the group of papers upon engine tests by M. E. Cooley, Prof. Goss and E. H. Foster, which are referred to elsewhere in this issue, were read in succession. The closing paper, by B. C. Ball, upon cylinder proportions for compound engines, was also grouped with these, and all four papers were then discussed briefly. As time was getting short, there was but little discussion. One printed discussion was submitted illustrating a simple compensating device for direct-acting steam pumps, which was intended to do the same work as the well-known Worthington compensating cylinders. F. A. Halsey criticized a

›d used in the test reported by Mr. Cooley in determining ump friction. This method was by indicating the steam ›ump cylinders and as the total power of the engine was a small percentage of error in the indicator might indicate siderable difference between the steam and water ends of the which would wrongly be attributed to friction. He also ized the placing of springs in the indicator cylinder, where would be subjected to temperature conditions.

lowing the papers there was a brief topical discussion of reservation of penstocks, in which D. J. Lewis gave as his ience that Bitumastic enamel, an English preparation, was ıperior to anything he had used.

arrangements made by the local committee, J. B. Stan-, chairman, were so complete and the hospitality extended members of the local society and other residents identified he same interests, was unstinted. The thanks of the society ese many attentions were extended to their hosts and the favorable comments that were made showed that the formal ıtion of thanks was sincerely felt by those who were so ate as to be guests upon this occasion.

Wednesday afternoon, a notably pleasant trip was made for al miles down the Ohio River in a specially chartered ier. Before the return a stop was made at the immense ston plant of the United States Cast Iron Pipe and Foundry ›any.

ırsday afternoon trips were made by part of the members Cincinnati Oyster and Fish Company's refrigerating plant; ›y others to the shops of the Bullock Electric Mfg. Co., lunch was served.

Friday the day was taken for a trip to Dayton to inspect orks of the National Cash Register Co. Every opportunity given to investigate the well-known industrial features that ıanagement of this company have adopted. These were described and illustrated in two articles published in the of MACHINERY for September and October, 1898. Upon l a group picture was taken of the guests and they were conducted to the lecture hall where stereopticon views were ı. The last view was from a negative made but a short time e group, much to the surprise of every one. The guests then taken through the works and refreshments were d.

plan of personally conducting visitors to points of interest the city was adopted and the ladies who were present par-rly enjoyed this arrangement.

Thursday night the reception and dance at the Hotel Alms ne of the most enjoyable occasions of the kind at any of the ngs of the society.

* * *

## ЭHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—8.

### BALL AND IRREGULAR TURNING.

W. H. VAN DERVOORT.

th the regular tools and feeds on the engine lathe, plane, lrical and conical surfaces are readily machined. If the sur-

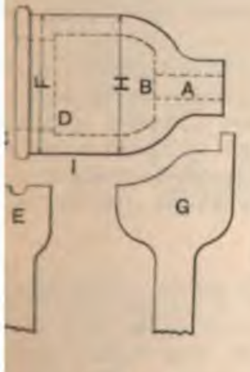


Fig. 66.

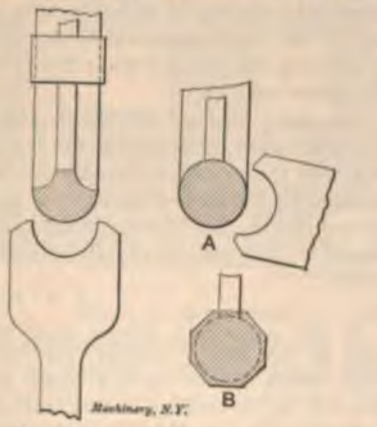


Fig. 67.

s spherical or of irregular outline, a forming tool or some al attachment must be used on the lathe to produce the re-d outline. If the work is of circular section, the forming can usually be used to excellent advantage, as illustrated in Fig. 66. In this case the tail-stock cap shown in the figure is first chucked, bored at A, faced at B and threaded at D. It is then placed on a threaded mandrel and driven on the centers. The forming tool E, which is secured in the ordinary tool-post, forms the bead and is set in until the proper diameter at F is obtained. The tool G, held in like manner, forms the hub and rounded end of the cap, the tool being set in until the diameter at H is equal to that at F. A common tool is then used to produce the cylindrical surface I. If the length I is short it would be possible to combine the two forming tools into one. As the cutting edge is a long one it is, in any event, desirable to rough off the scale and true up the casting before applying the forming tools. This can be done by operating the regular feeds by hand. If the work does not run true when the forming tool is set to the cut, it will be difficult to produce satisfactory results, as the spring of tool and work will vary at different points in the revolution. The length of cutting edge that can be employed depends in any case upon the stiffness of the work and the rigidity of the lathe in which the work is to be done. Another illustration of this system of forming is shown in Fig. 67. Here the rim of a hand wheel rounded by the forming tool is shown. If the section of the rim is a full circle, as at A, two settings of the tool are required, one of which is illustrated in the figure. It is here even more important than in the example shown in Fig. 66 to first rough the stock until it runs true, as the heavy cut of the forming tool will otherwise spring the work so that it will not run true when finished. For roughing out the rim a side-cutting tool can be used to good advantage, setting it at different angles to produce a section similar to that shown in the figure at B. If the tools are carefully made and kept in good condition, very satisfactory results can be obtained upon a wide range of work, similar to the above examples.

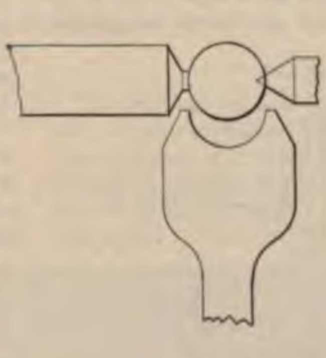


Fig. 68.

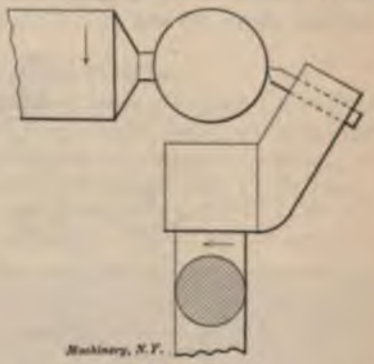


Fig. 69.

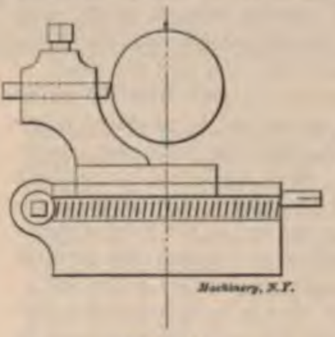


Fig. 70.

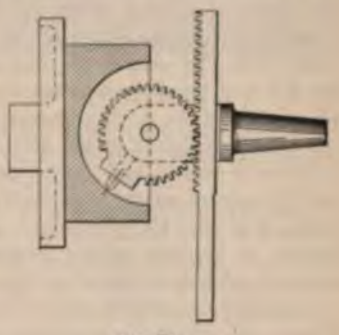


Fig. 71.

The tools should be so made that they can be sharpened by grinding from the top surface. If the tool is carefully made and the scale removed from the stock, it will do a larger amount of work before dulling materially. Forming tools of this character are not expensive to make, and, when any considerable amount of similar work is to be produced, will pay for themselves very quickly.

The tool shown in Fig. 67 may be used for turning balls from stock held between centers or in a chuck, as shown in Fig. 68. If the stock is held in the chuck, the ball will not be disfigured with the center bearing. A small tip will, however, remain where cut from the body of the stock. In forming balls in this manner it is necessary to caliper the diameter carefully, advancing the tool only far enough to produce a true sphere. This method will be found very convenient in the forming of balls on the ends of handles, the ball in such cases not being cut from the body of the stock, and perfect spheres not being necessary. In Fig. 69 is shown a simple ball-turning device. The shank A of the cutter holder is round and fits in a suitable bearing which is clamped to the tool block. On the outer end of the shank is secured a long lever or preferably a worm and gear mechanism for rotating the cutter head and tool to the work. Although a truer sphere can be obtained with this device than by the use of the forming cutter shown in Fig. 68, the surface will not be as smooth as with the latter. The more elaborate device shown in Fig. 70 is better adapted to the turning of larger balls than either of the methods above referred to. While this attachment can be provided with a shank and held in the tool-post, it is much more rigid when secured directly to the tool-block or in the place of the compound rest. The construction of the device is clearly shown in the figure. In order to produce a true sphere the center of rotation of the cutter-carrying disc must be exactly under the center of rotation of the work, and the distance of the point of the tool from the center of rotation then determines the radius of the ball. By setting the tool with its point past the center of the disc and bringing the center of the disc back from the center of rotation of the work a concave section can be produced in the work, the character of the section depending upon the relative position of centers and tool point. With work held in the chuck and the center of the disc under the center of rotation of the work, it is possible to produce on the end of the work either a convex or concave surface depending on whether the point of the tool is back or ahead of the center of rotation of the disc.

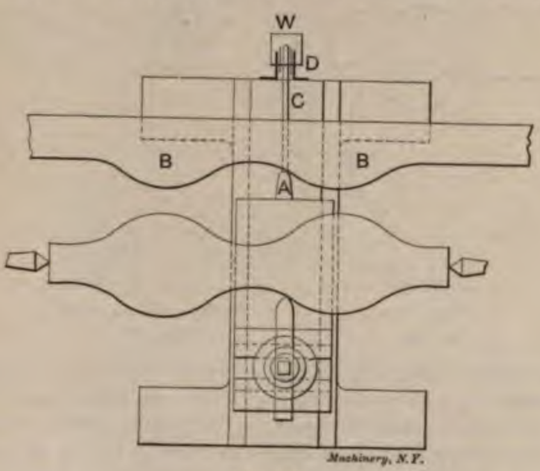


Fig. 72.

A convex or concave surface can readily be turned with a tool held in the common compound rest, the only difficulty being in the control of the feed. When the cuts are light, however, satisfactory results can be obtained by moving the rest by hand, having its clamp bolts tightened just enough to steady the motion.

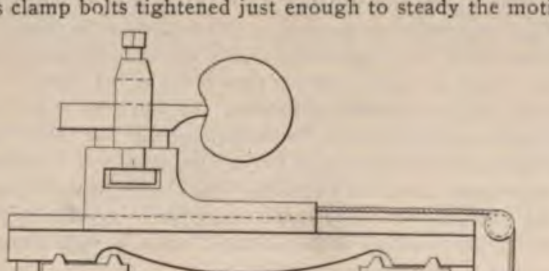


Fig. 73.

The boring of spherical sockets can readily be accomplished by means of the special attachment shown in Fig. 71. The small gear is mounted on the flattened end of a stub center which is fitted to the tail spindle bearing. The cutting tool is secured in the face of this gear and the gear caused to rotate by means of the rack which is carried in the tool-post and actuated by the regular cross-feed on the lathe. The cutting edge of the tool must be set at the height of the center.

In cases where the outline is irregular and too long to be conveniently produced with the forming tool, a common tool may be made to do the work, its motion being controlled by a guide having the same outline as the one desired and controlling the tool on the taper-attachment principle. The general arrangement is shown in the top view of a lathe carriage, Fig. 72. In this case the slide is disconnected from the cross-screw. BB is the guide which is secured to the bed of the lathe and independent from the carriage. The finger A is secured to the slide and bears against the guide B B. A cord C is attached to the slide, passes over the pulley D and carries the weight W which serves to hold the finger A to the guide at all times. The point of the cutting tool must travel with the finger A, and, tracing the outline of B B, produce the same outline on the work. In this arrangement the tool is usually set to the work by adjusting it through the tool-post. A threaded adjustment in the finger A makes a good adjustment for the finer tool settings. This method is applicable only when the cross-section of the work is round.

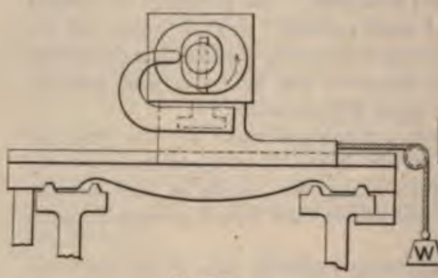


Fig. 74.

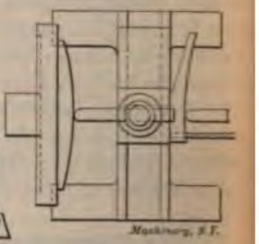


Fig. 75.

If an irregular cross-section is required, a different arrangement involving the use of a pattern or dummy is generally employed. The dummy is a pattern of the same cross-section as that required on the work and is mounted either on the same axis as that of the work rotation or on a separate axis so geared as to make the same number of revolutions as the work. When the work is short and both it and the pattern can be mounted on the same axis, the former method is, owing to its simplicity, preferable. In Fig. 73 is illustrated the former method. As in Fig. 72, the cross-feed screw is disconnected from the cross-slide and a weight provided for holding the finger against the pattern B, which rotates with the work. A second tool-post, back of the one carrying the finger, holds the tool that operates on the work. It is evident that the motion of tool point and finger is the same and that the outline of the work will be the same as that of the pattern. If the two tool-posts cannot be set sufficiently far apart to allow for the required length of cut, the finger can be carried on a suitable bracket secured to the side of the tool-block. It is quite possible by careful adjustment to start the cut with the use of the pattern and allow the finger to lead from the pattern on to the work, thus enabling a long cut to be made with a short pattern. A careful readjustment of the finger is required for each cut in this case. It is not necessary that the pattern be of the same size as the work section, as it is frequently desirable to make it of a different size.

It is quite possible to adapt the method of Fig. 73 to internal work. In Fig. 74 the work is secured on the tool-block and the pattern on the boring bar. In this case the work moves with the pattern instead of the tool. The example shown illustrates the method of boring an elliptical hole. By using a movable head boring bar a thin pattern is all that is required. As a wide range of patterns can be used many forms of cams can be produced by the above method.

The same method shown in Fig. 72 is applicable to face work on stock held against the face plate or in the chuck. In this case the weight is placed at the end of the bed, the guide is secured to the cross-slide and the finger to the tail-stock, all as shown in Fig. 75. Many outlines can readily be produced in this manner. The tool is operated by the regular cross-feed mechanism.

* * *

In his interesting article upon the genesis of machine design in the March number, Mr. W. H. Sargent spoke of the slide which moves up and down in the handle of a monkey wrench as resembling a toy monkey, and thereby drew an analogy. To this Mr. H. E. Madden writes: "The wrench is not named from this, neither is it so called because it is a handy thing to "monkey" with. The right name is "Moncky." Charles Moncky, the inventor of it, sold his patent for $2,000 and invested the money in a house in Williamsburg, Kings County, N. Y., where he afterward lived."

MACHINERY.

July, 1900. No. 11.

# TESTING THE STRENGTH OF MATERIALS.—4.

## ION TESTS CONTINUED, WITH A DESCRIPTION OF THE EMERY TESTING MACHINE.

EDWARD F. MILLER.

ves a general view of a 300,000 pound Emery testing ilt by Wm. Sellers & Co., for the Massachusetts Inechnology. The machine can test in compression speco 18 feet in length and in tension up to 13 feet. The travel of the loading piston is 42"; the maximum ed of the loading piston is 4½" per minute. The linder is at the right end of the cut, the weighing head

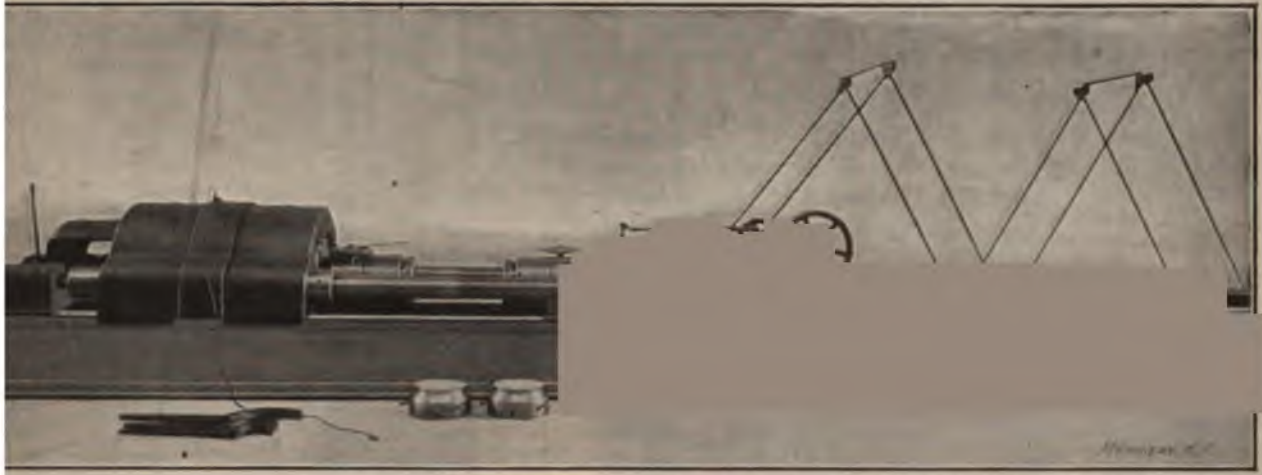


Fig. 1. General View of Emery Testing Machine.

nd. Both of these castings are supported by, but not a steel frame which forms the bed of the machine.

l screws 7" in diameter run the entire length of the They are threaded for a length of about 19 feet. They gh the weighing head and are securely fastened to it ts. Castings through which the screws can slide supht hand end of the screws.

nders containing buffer springs are bolted to the left f the frame. These springs push on the end of the s.

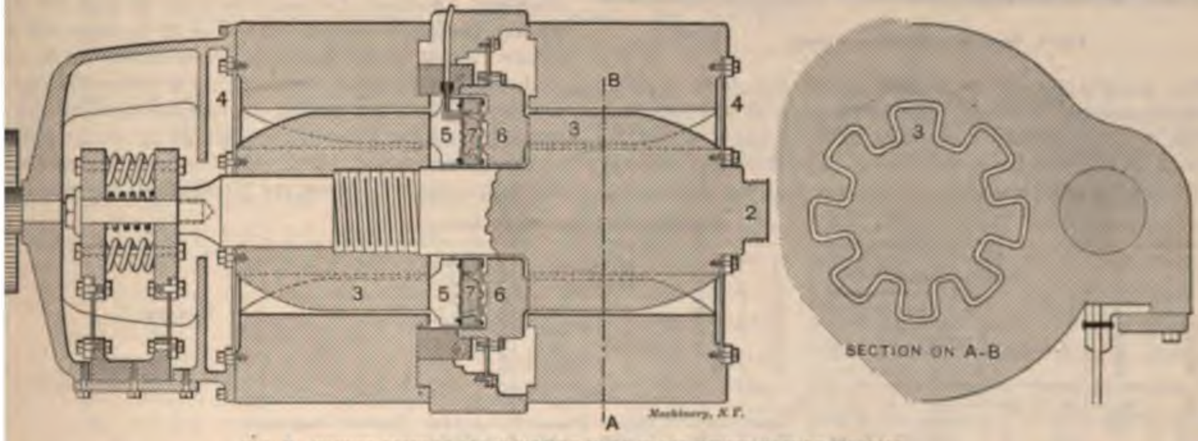


Fig. 2. Section through the Weighing Head of the Emery Testing Machine.

tension specimen breaks suddenly, the straining cylin- to the right and the weighing head and screws recoil in this way the buffer springs get an additional load oil, till finally they are compressed sufficiently to be t the weighing head to the right. Once started, the s back to its original position. The 7" steel screws ry whatever load may be put on the specimen. If the s in tension, the screws are under compression and

### The Straining Cylinder.

The straining cylinder is a closed hydraulic cylinder with piston and piston rod packed with cup-shaped leather packing rings. The cylinder is entirely filled with oil, which is supplied and exhausted through the jointed folding pipe seen at the right of Fig. 1. If the machine is working in tension, the oil under pressure enters at the left hand end of the cylinder and an amount of oil equal to that entering is driven out of the other end of the cylinder, back through one set of the folding pipes to the suction chamber of the power pump which forces the oil.

The straining cylinder may be moved along the bed to such positions as the different lengths of test pieces may necessitate. This is accomplished by rotating two large nuts on the 7" steel screws, these nuts turning inside the enlargements seen on the sides of the casting Fig. 1. The nuts are 4" narrower than the width of the recess in which they turn, thus allowing for the recoil already spoken of. After moving the straining head to a new position on the screws the nuts must be brought up against the proper bearing side of the recess. For tension work the nuts should be against the right hand side of the recess, and unless this is looked to very carefully the machine may be injured. While moving the straining head the nuts are driven by pinions engaging with spur gears on the outside of the nuts and the pinion shafts are in turn driven through sets of bevel gears by a shaft turned by a rope wheel. An epicyclic train of gears, serving as differential gears, is introduced in this driving mechanism, the object being to keep the resistance offered by the two nuts the same. If, for any reason, one nut should advance faster than the other, due perhaps to a slight difference in the pitch of the two screws, that nut, on account of the added work, would turn harder than the other nut. The differential motion now operates and causes the nut moving with the less resistance to turn at a greater speed till it catches up with the other.

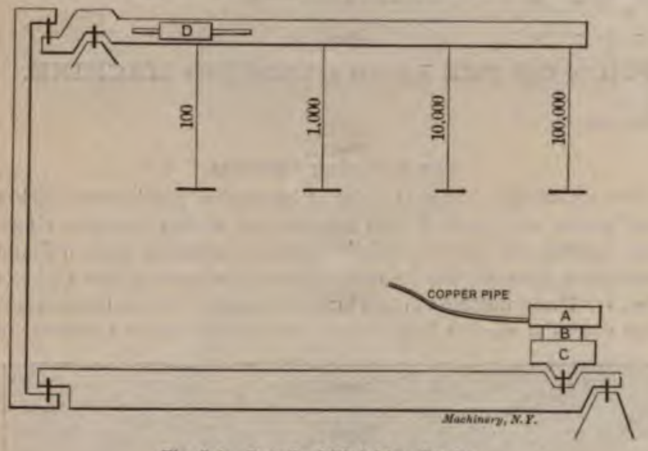


**Fig. 3 A. Detail of Weighing Device.**

### Weighing Head.

A longitudinal section through the weighing head is shown by Fig. 2. Any load applied by the straining cylinder is transmitted through the specimen to a draw bar marked 2 at the weighing end of the machine. Fastened to the draw bar there are two fluted steel pistons marked 3, 3. This bar with pistons is held in place by annular flat steel discs ⅛ of an inch thick. These discs marked 4, 4, hold the bar suspended inside the outer casting. Between the pistons there are three castings, 5, 6, 7, connected, as shown in the drawing. The outer of these is supported by flat springs attached to the main casting. The thickness of these three castings is a trifle less than the distance between the bearing surfaces of the outer castings. Between two of these castings there is an outer diaphragm of brass .018" thick. This brass is spun into recesses, as shown in the drawing. A space of 1-32" wide between the two sides of the diaphragm is filled with a mixture of glycerine and alcohol. The diaphragm is connected with the weighing mechanism in the scale case by a small copper pipe having a hole about 1-20" in diameter. At the left hand end of the draw-bar there are five springs under compression. By means of the hand wheel at the extreme left, the force of these springs can be taken as a push, or as a pull, on the draw-bar. These springs exert force enough to more than overcome the resistance to bending offered by the steel discs supporting the draw-bar. Suppose the machine is to be used for compression work. The hand wheel is turned so as to cause the five springs to exert a pull on the draw-bar. As a result, the draw-bar moves to the left a very small distance. As it moves the right hand piston on the draw-bar pushes the castings holding the diaphragm to the left till the left-hand one brings up on the bearing surface of the outer casting. The extra force of the springs causes a slight squeeze to be given the liquid inside the diaphragm. This

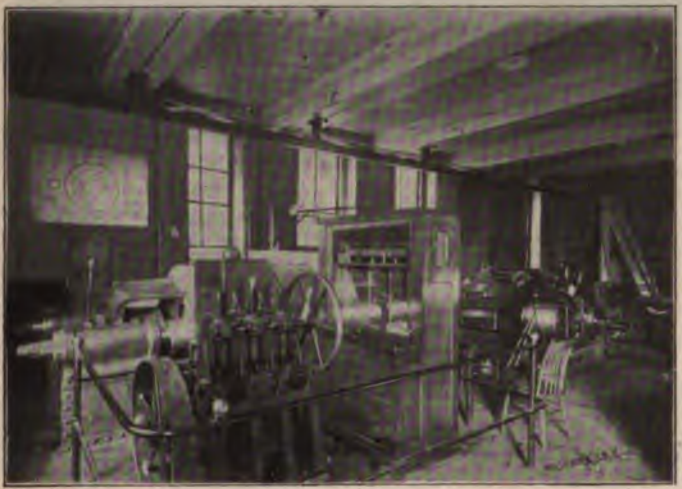


**Fig. 4. Hydraulic Pump and Scale.**

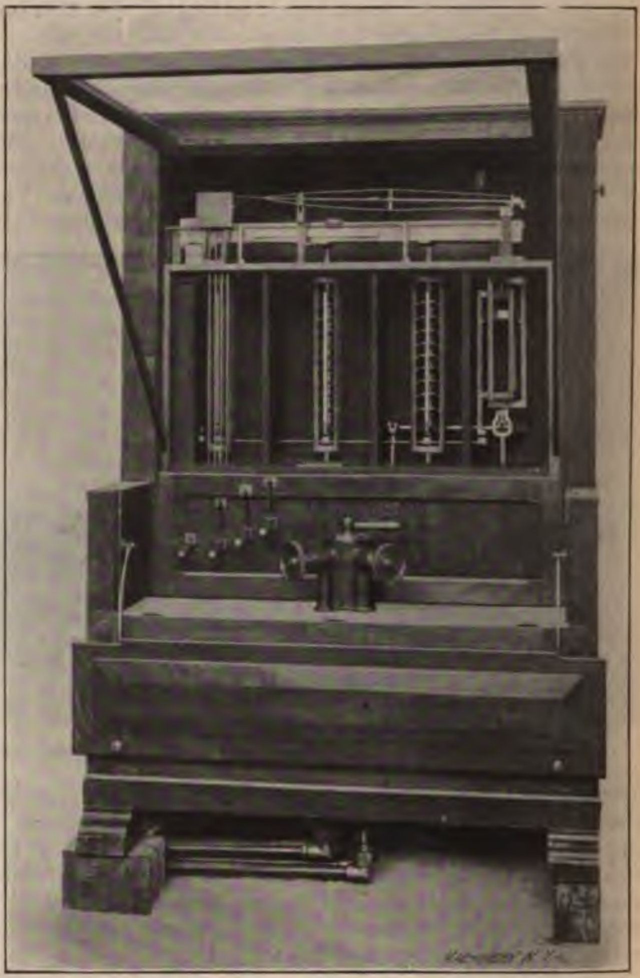


**Fig. 3 B. Scale Case and Operating Valve.**

**Compression of Spruce Column.**

| Weight | Gauge Length. | Size of Column. | | | | Sectional Area | Ratio of length to least side. | Ultimate Strength. | | Ratio of Stress to Strain, commonly called modulus of elasticity. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Length. | | Width. | Depth. | | | Actual. | Lbs. per sq. in. | | |
| Lbs. | In. | Ft. | In. | In. | In. | Sq. in. | | | | | |
| 226 | 100 | 17 | .0 | 8.00 | 8 00 | 64.00 | 25.50 | 155,000 | 2,422 | 1,297,800 | Deflected diagonally. |
| 276 | " | 18 | .0 | 8.25 | 8.06 | 66.52 | 26.79 | 140,000 | 2,105 | 1,385,600 | " " |
| 357 | " | 16 | .0 | 10.00 | 10.00 | 100.00 | 23.00 | 274,000 | 2,745 | 1,656.300 | " " Crushed 5 feet from platform. |
| 337 | " | 15 | .0 | 10.00 | 10.00 | 100.00 | 18.00 | 261,300 | 2,613 | 1,552,800 | " downward. " at center. |
| 162 | " | 11 | 1.00 | 8.13 | 8.13 | 66.02 | 16.37 | 180,000 | 2,727 | 1.405,200 | " diagonally. " 4½ feet from platform. |
| 188 | " | 9 | 10.75 | 8.00 | 12 13 | 97.00 | 14.81 | 191,000 | 1,969 | 1,009,200 | " horizontally. " 1' 3" from respective ends. |
| 182 | " | 9 | 7.88 | 7 88 | 12.00 | 94.50 | 14.71 | 188,500 | 1,995 | 982,540 | " downward. " at knot 18" from end. |
| 126 | 50 | 9 | 0.13 | 8.13 | 8.13 | 66.02 | 13.31 | 191,500 | 2,901 | 1,439,900 | Crushed 1' from platform. |
| 100 | " | 7 | 6.00 | 8.13 | 8.13 | 66.02 | 11.07 | 170,800 | 2,507 | 1.442,700 | " 6" " " |
| 133 | " | 9 | 6.38 | 8.13 | 8.13 | 66.02 | 14.45 | 175,700 | 2,662 | 1,357,300 | " 3' " " |
| 66 | " | 7 | 8.38 | 7.75 | 7.75 | 60.06 | 8.82 | 191,900 | 3.195 | 1,222,400 | " 1.5' " " |
| 66.5 | " | 5 | 9.75 | 7.88 | 7.88 | 61.03 | 9.00 | 156,000 | 2,556 | 834,270 | " " " " |
| 104 | " | 7 | 11.00 | 8.25 | 8.25 | 67.03 | 11.69 | 175.400 | 2,617 | 857,380 | " " " " |
| 200 | 100 | 9 | 10.25 | 10.13 | 10.13 | 102.62 | 11.67 | 182,800 | 1,784 | 884,000 | Deflected horizontally. Crushed at end. Part of column tested December 8, 1894. |
| ... | 100 | 12 | 00.00 | 10.00 | 10.00 | 100.00 | 14.40 | 190,000 | 1,900 | 1,180,000 | Deflected diagonally. Crushed at center. |
| ... | ... | 12 | 00.00 | 10.00 | 10.00 | 100.00 | 14.40 | 192,000 | 1,920 | ........ | Crushed near one end. |

ncreased pressure is transmitted through the copper pipe to the cale case.

In the scale case, Fig. 3A, there is an inverted steel cup A, aving a brass diaphragm on its lower face. This cup connects hrough the copper pipe with the annular diaphragm already described. Pressure on the diaphragm is transmitted through the ieces B and C to the lever system, where it may be weighed y putting weights in the different scale pans.

The initial load put on by the extra force of he five springs is counter-balanced by moving the balance weight D to the right. The nife edges used in the lever system are thin ieces of steel, driven into slots cut into the evers. The machine has to be rated, when nade, by comparing it with a sensitive lever nachine made specially for this use.

Fig. 3B shows the scale case and operating alve. Fig. 4 shows the location of the hydraulic pump with reference to the scale case. The hydraulic pump is operated through a ink and link block, the position of which can e varied at will by turning the hand wheel. The amount of oil pumped can be adjusted in his way or it can be controlled by the reguating valve at the scale case. The two valves vith circular handles are needle valves. the ight hand one admitting oil from the pump o the valve chamber and the left hand valve erving as a leak valve. Inside the valve hamber there are three ports in a horizontal eat, the right hand port leading to the tenion end of the straining cylinder, the left and port to the compression end of the cyliner and the center port to the overflow tank t the suction of the pump. The horizontal andle at the top moves a cup-shaped valve vhich may be made to connect either port vith the center port, and is kept on its eat by the pressure of the oil. If the hanle is turned so as to uncover the right hand port and to connect he center and left hand port, the oil under pressure enters the ension side of the straining cylinder and the oil driven out in ont of the piston is returned underneath this little valve to the ump.

Fig. 3B also shows the method of weighing the load. The eights are gold-plated discs carried in cages moved by four hanles. Suspended from the weighing beam are four cages similar o the others but with lugs spaced in such a way that if the cage noved by a handle is raised one notch, one disc is transferred rom the handle cage to the beam cage. At the same time the notion of the handle indicates, through figures at the end of he indicator needle, the number of weights on the beam.

Assuming the extreme motion of the indicator needle to be 2", the motion of the draw-bar 2, 3, 3, calculated from the ratio of the hydraulic chambers and the multiplication of the levers figures somewhere about 1-150,000 of an inch. The motion is actually greater than this.

There is but little transfer of liquid from the diaphragm to the scale case and if the indicator needle is kept from vibrating, there is no error introduced into the weighing by the stiffness of the steel knife edges or by the steel discs 4, 4.

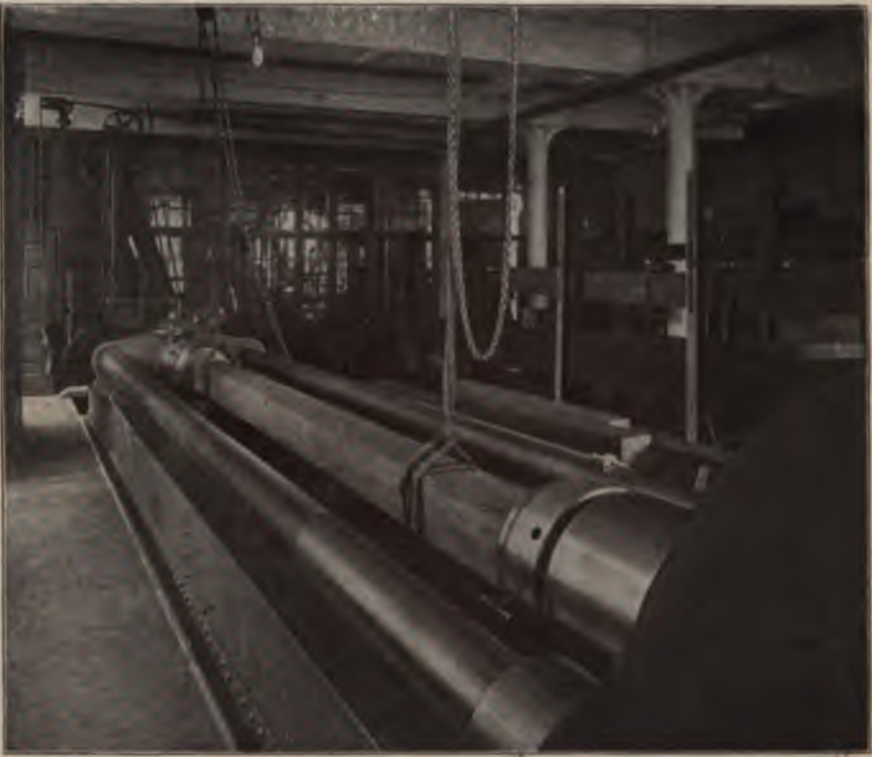


Fig. 5. Testing Machine, as located in the Laboratory.

Fig. 5 shows the machine as installed at the Engineering Laboratories Massachusetts Institute of Technology.

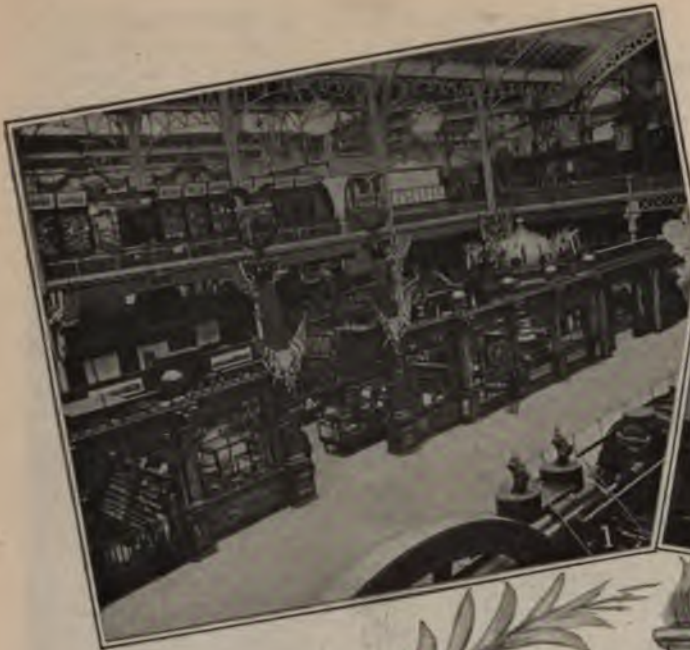
It may be of interest to quote here one of the many sets of tests made on this machine by the students at the Massachusetts Institute of Technology as a part of their regular laboratory work.

Tests of Wooden Columns.

| Kind. | Weight. | Gauge Length | Size of Column. Length. | | Width. | Depth. | Sectional Area. | Ratio of length to least side. | Ultimate Strength. Actual. | Pounds per sq. in. | Ratio of Stress to Strain commonly called modulus of elasticity. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lbs. | In. | Ft. | In. | In. | In. | Sq. In. | | | | | |
| Yellow Pine | 230 | 100 | 13 | 6.38 | 8.13 | 8.13 | 66.10 | 19.96 | 289,000 | 4,380 | 1.468,000 | Deflected Diagonally. Crushed at center. |
| Yellow Pine | ... | 100 | 10 | 7.25 | 7.75 | 7.75 | 56.36 | 16.48 | 153.700 | 2,730 | 1,079,000 | Crushed at knot at middle.<br>These columns planed and bored through center. 2" hole. |
| Yellow Pine | ... | ... | 10 | 7.25 | 7.75 | 7.75 | 56.36 | 16.48 | 180,000 | 3,190 | ........ | " 1 ft. from end. |
| Yellow Pine | 217 | 100 | 10 | 7.25 | 7.75 | 7.75 | 56.36 | 16.48 | 210,900 | 3,740 | 1,893,000 | " at center. |
| Yellow Pine | 174 | 100 | 10 | 7.25 | 7.75 | 7.75 | 56.36 | 16.48 | 217,000 | 3,850 | 1,568,000 | " at center. |
| Oak . . . | 240 | 50 | 8 | 4.00 | 8.00 | 10.38 | 83.04 | 12.50 | 159,400 | 1,921 | 994,000 | Tested with oak bolster. Failed by splitting and crushing at end next to bolster. |
| Oak . . . | 130 | 50 | 4 | 6.25 | 8.00 | 10.25 | 82.00 | 6.78 | 156,000 | 1,902 | 1,575,000 | Tested with oak bolster. Failed by splitting at end next to bolster. |
| Spruce . . | 85 | 50 | 5 | 0.50 | 9.50 | 9.88 | 93.86 | 6.37 | 166,000 | 1,770 | 1,082,000 | Tested with oak bolster. Failed by splitting at end next to bolster. |
| Spruce . . | 125 | 50 | 7 | 2.25 | 7.50 | 12.00 | 90.00 | 11.50 | 169,600 | 1,900 | 1,812,000 | Tested with oak bolster. Failed by splitting at end next to bolster. |
| Spruce . . | 88 | 50 | 5 | 5.69 | 9.50 | 9.88 | 93.86 | 6.91 | 198,000 | 2,110 | 1,316,000 | Tested with maple bolster. Failed by splitting at end next to bolster. |
| Spruce . . | 88 | 50 | 5 | 6.00 | 9.75 | 9.75 | 95.06 | 6.77 | 250,000 | 2,730 | 1,154,000 | Tested with maple bolster. Failed by splitting at end next to bolster. |
| Oak . . . | 151 | 50 | 4 | 6.75 | 4.75 | 7.75 | 36.81 | 11.53 | 170,300 | 1,870 | 884,000 | Tested with oak bolster. Failed by crushing and splitting column at end next to bolster. |
| Spruce . . | 181 | 100 | 11 | 0.00 | 9.50 | 9.63 | 91.49 | 13.89 | 143,000 | 1,560 | 1,443,000 | Tested with oak bolster. Failed by splitting at end next to bolster. |
| Spruce . . | 183 | 100 | 9 | 9.50 | 9.50 | 9.50 | 90.25 | 12.37 | 153,600 | 1,700 | 1,526,000 | Tested with oak bolster. Failed by splitting at end next to bolster. |
| Spruce . . | 275 | 100 | 11 | 11.50 | 10.00 | 10.00 | 100.00 | 14.35 | 118,000 | 1,380 | 889 700 | Tested with oak bolster. Failed by splitting at end next to bolster. |
| Spruce . . | 260 | 100 | 11 | 5.75 | 10 13 | 10.13 | 102 62 | 13.60 | 145,000 | 1,410 | 1,001,000 | Tested with yellow pine bolster. Failed by splitting and crushing at end next to bolster. |

* * *

The highest artificial heat yet produced is that obtained by the electric furnace and is supposed to have been between 6,500 and 6 700 degrees Fahrenheit. It should be understood that the electric furnace is simply an electric arc inclosed within a closed crucible of incombustible material such as graphite or fire-clay.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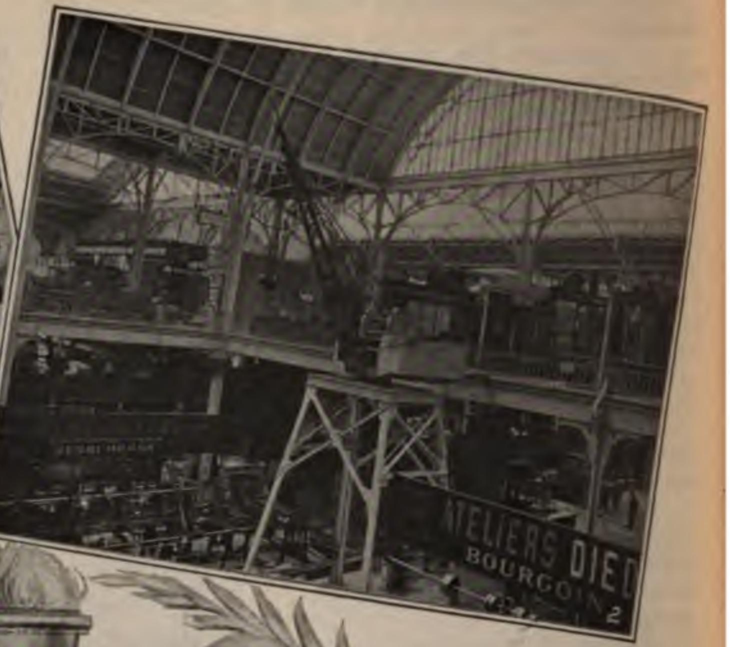

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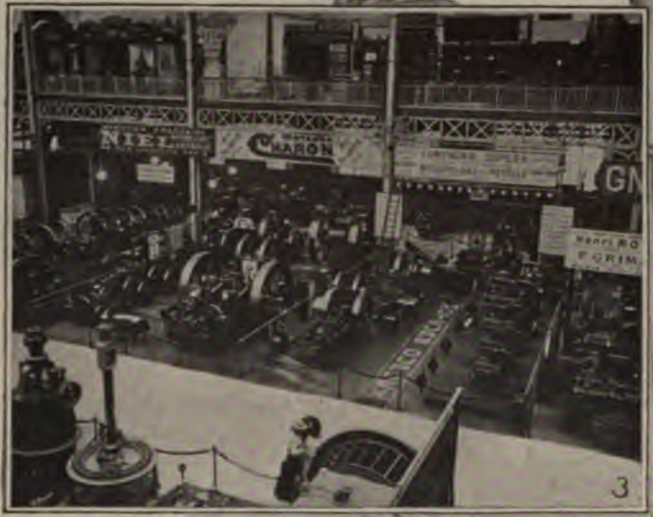

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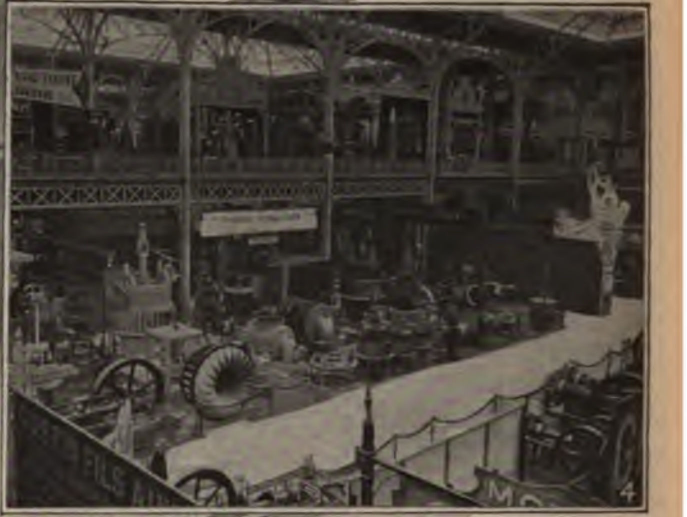
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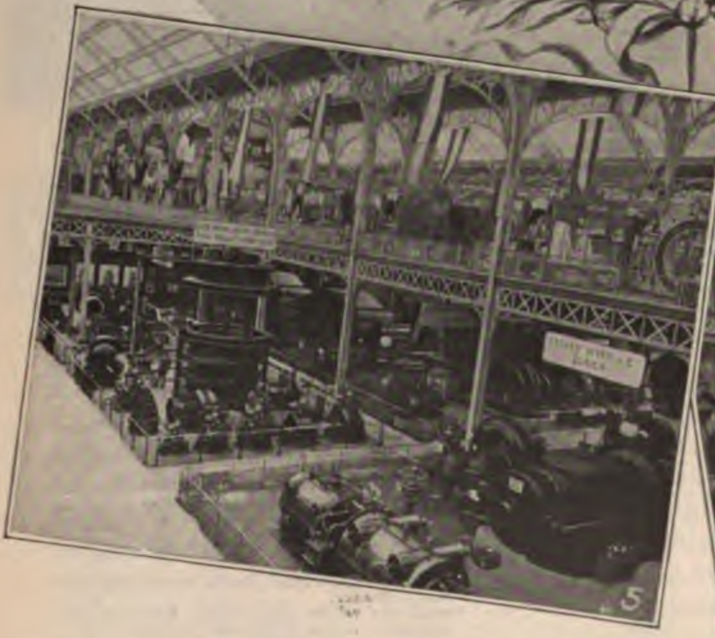
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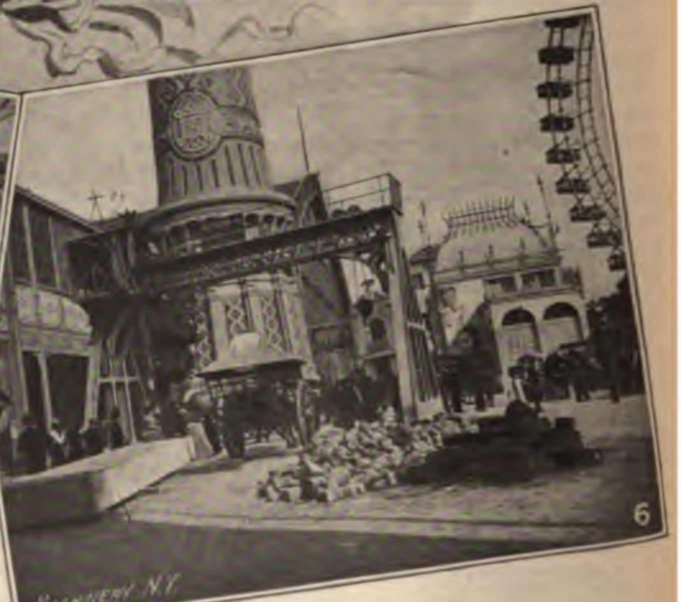

6

1. Facade of the United States Section of the Department of Mines and Metallurgy.
2. Textile Machinery in the French Section, with Electric Crane.
3. French Internal Combustion Engines.
4. French Hydraulic Machinery with Belts of Various Materials in the Balcony.
5. Swiss Hydraulic and Electric Machinery.
6. Portable Traveling Crane, with Base of Power Plant Chimney in the Background.

VIEWS OF MACHINERY EXHIBITS AT THE PARIS EXPOSITION.

# INERY AT THE PARIS EXPOSITION.

## W SYSTEM OF GROUPING-BRIEF NOTES ABOUT 'HE DIFFERENT CLASSES OF MACHINERY.

ANDREW D. FULLER.

mer exhibitions the machinery has generally been
in one large pavilion of machinery. This grouping,
convenient for the study of machinery as a whole, has
ded the opportunity for the appreciation of the very re-
improvement of machinery in relation to the mechani-
of the great industrial establishments, and the better-
their products found in the Exposition of 1900. On
ıd throughout the entire extent of the main grounds, as
t the Vincennes annex, are found interesting exhibits
nery side by side with their products. The principal
is made in the Champ de Mars section, in the succes-
pavilions on the north and south sides having as a
e immense electrical display on the western end. There
and best efforts of France and the foreign countries
ıyed. A large space in this building is given over to the
tates for the display of electrical apparatus and acces-
hile the main American machines are located in a
uilding at Vincennes.

departments there are excellent working models vary-
ale from the actual size for machines of considerable
ns to less than a half inch to the foot where whole in-
plants with all the details are accurately reproduced.
ining section there are some of especial merit. There
the steam plant with its battery of boilers adjacent to
rful engines for pumping air and water or generating
; the hoisting engines, correct even to the materials of
s used; the elevators carrying three and four tiers of
n with ore from deep shafts shown in the large draw-
g about the exhibits. These miniature cars are dis-
on the proper tracks for conveying the ore to the
where it is dumped automatically, crushed, sorted and
the proper bins. There are a number of full sized coal
th their customary bracing, tracks, cars and hoisting
.

er hand are the iron ore and the method of its extraction
ting, the machines for working the iron and a model of
ame building. One of these machines of especial in-
5,000 H. P. reversible three-cylinder rolling engine,
60 revolutions per minute, built by Ehrhardt & Sehmer,
, for the Imperial Steel Works of Japan at Yawatamura,
shipped after the Exposition. This is the smallest of
e of this type built by them.

shows the solid electro-bronze and marble facade of the
States section in the Department of Mines and Metal-
This is one of the handsomest facades in the Exposition.
ound floor of the building devoted to threads and fabrics
occupied by machinery used in the textile industry.
, weaving, printing and winding machines are in daily
. Several interesting hand looms and a hand em-
g machine have attracted considerable attention. The
exhibits in this section, as well as in many others, are
worthy of mention. In the French section is a ma-
winding rubber with cotton or silk, to make the thread
weaving elastic bandages. This is ingeniously con-
in duplicate to be operated by hand or a motor and
e of extension for an indefinite number of spools. On
rmost horizontal support turns the spool, bearing the
read, which then passes through two sets of horizontal
ne set immediately below the spool and the other set
rizontal support below the spools bearing the exterior
. These rollers hold the thread with sufficient firmness
ain the initial tension necessary to cause the thread to
after winding and thus produce a firm covering. The
hread is fed through the vertical axes of the two spools
the silk or cotton, situated between the horizontal roll-
upper turning right-handed for the first winding, the
rning left-handed for the second winding, to the revolv-
ving cans below. The whole is cleverly arranged to be
rked by one belt.

shows some of the textile machinery in the French
also an electric crane for unloading the exhibits from
below to the balcony level.

Fig. 3 shows a portion of the French vapor engine exhibits. The great enthusiasm displayed by the French for motor vehicles has aroused a lively interest in vapor engines. Those shown in the photograph are principally stationary engines, ranging from 1½ to 100 H. P.; the principal improvements noticeable being an economical increase of motive power. The smaller portable motors are exhibited in the adjoining space to the right of the picture. There are many electrical vehicles in use, but the vapor motors are the general favorites. As a rule they operate with an annoying jar and noise from the exhaust.

A complete exhibit of wood-working machinery is found in the same building. The logs are passed through the vertical saws of the ripper, cutting the whole, at the same time, into boards of any desired thickness. Then follows the various machinery for planing, trimming, turning and working.

In hydraulic machinery both France and Switzerland have extensive exhibits of horizontal and vertical turbines for low and high heads.

Darblay Père et Fils have a complete paper machine in active operation showing the whole process from the making of the wood or linen-pulp, its digestion, bleaching, dyeing and preparation for running, to its transit through the press from the agitators to the calenders. France has added a unique retrospective exhibition of the wonderful rise of the paper-making industry.

In printing machinery both France and Germany make a good showing. The superiority of American machinery is well illustrated by the press shown in the American Publishers' Building, where the Paris Exposition Edition of the "New York Times" is printed daily. Type-setting by machinery, matrix making and casting of a stereotype plate for a sixteen-page newspaper is in full view. The perfecting press of the Goss straightline type produces 50,000 eight-page papers per hour, printed, cut, pasted, folded and counted.

Fig. 4 shows French hydraulic machinery with belts of various materials in the balcony, that on the extreme right being a 2,000 H. P. belt made of strips of leather sewn together through the width of the belt.

Fig. 5 shows the Swiss hydraulic power and electrical machinery and a paper machine in the background.

Fig. 6 shows a portable traveling crane for unloading goods from cars at the Avenue Suffren entrance to the Electricity Building. Behind the crane is the base of the chimney of ornamental porcelain for the Avenue Suffren boiler house. The small building to the right is a post, telegraph and telephone station. A portion of the Great Wheel of Paris, 300 feet in diameter, carrying 1,600 people and modelled after the Ferris wheel exhibited at Chicago, is shown.

The Department of Finance exhibits a hand press for stamping medals and coins, of which there are a large variety on sale commemorating the Exposition. A constant crowd of spectators is gathered about the money press of The French Society of Mechanical Construction and that of L. Pinchart-Deny whenever in motion. The former, of the système Thounelier, turns out fifty medals per minute. The latter for stamping heavier medals claims an equal share of attention. An electric motor is geared directly to the horizontal shaft carrying the two vertical friction wheels on either side of the horizontal contact wheel and fixed to the vertical screw-pitched shaft carrying the die. By means of a hand lever, the polished surfaces of the friction wheels are thrown in contact with the leather bound rim of the die wheel, causing the die to descend with any desired speed. Automatic balances for separating the light, heavy and good coins are features of the mint exhibit.

* * *

One shop proprietor, who is using variable speed countershafts for his planers, states that as nearly as he can judge the final effect of the countershafts is to determine the highest speed at which the planer can be run. His mechanics adjust the speed of the countershaft to the highest practical point and then allow the planer to run at that speed, which is seldom varied. Even in the light of this experience he is still in favor of such countershafts. It is evident, also, that they are coming into more general use for planer driving, largely, probably, because they have been improved the past few years and now give less trouble than formerly. If any object to them as being not strictly in accord with the best ideas in mechanical construction, there is still open the plan of using stepped cones on the countershaft and the line shaft.

## LARGE TRAVELING-HEAD SHAPER.

The shapers made by the Morton Manufacturing Co., Muskegon Heights, Mich., have the distinguishing characteristics that they operate on the pull or draw-cut principle, the cutting stroke being during what is ordinarily the return stroke in the common type of shaper. The effect of this construction is to draw together the different parts of which the shaper is composed—to close the joints, as it were—while the cut is in progress, and the harder the machine is worked, the closer the parts are drawn together and the more rigid the tool. An unusually long shaper ram can be used without vibration when operated on this principle.

For reasons that will be obvious, this construction is peculiarly adapted for large and heavy work, as, for example, castings that are so large that they cannot be conveniently placed on the planer, but which have short faces or bearings to be faced off. Some very heavy machines have been constructed by the Morton Manufacturing Co. for such work, some of which are of a portable type, to be set on any floor plate on which the work happens to be located, and others of which are attached to their own floor plate. One of the latter class is shown in the accompanying illustration.

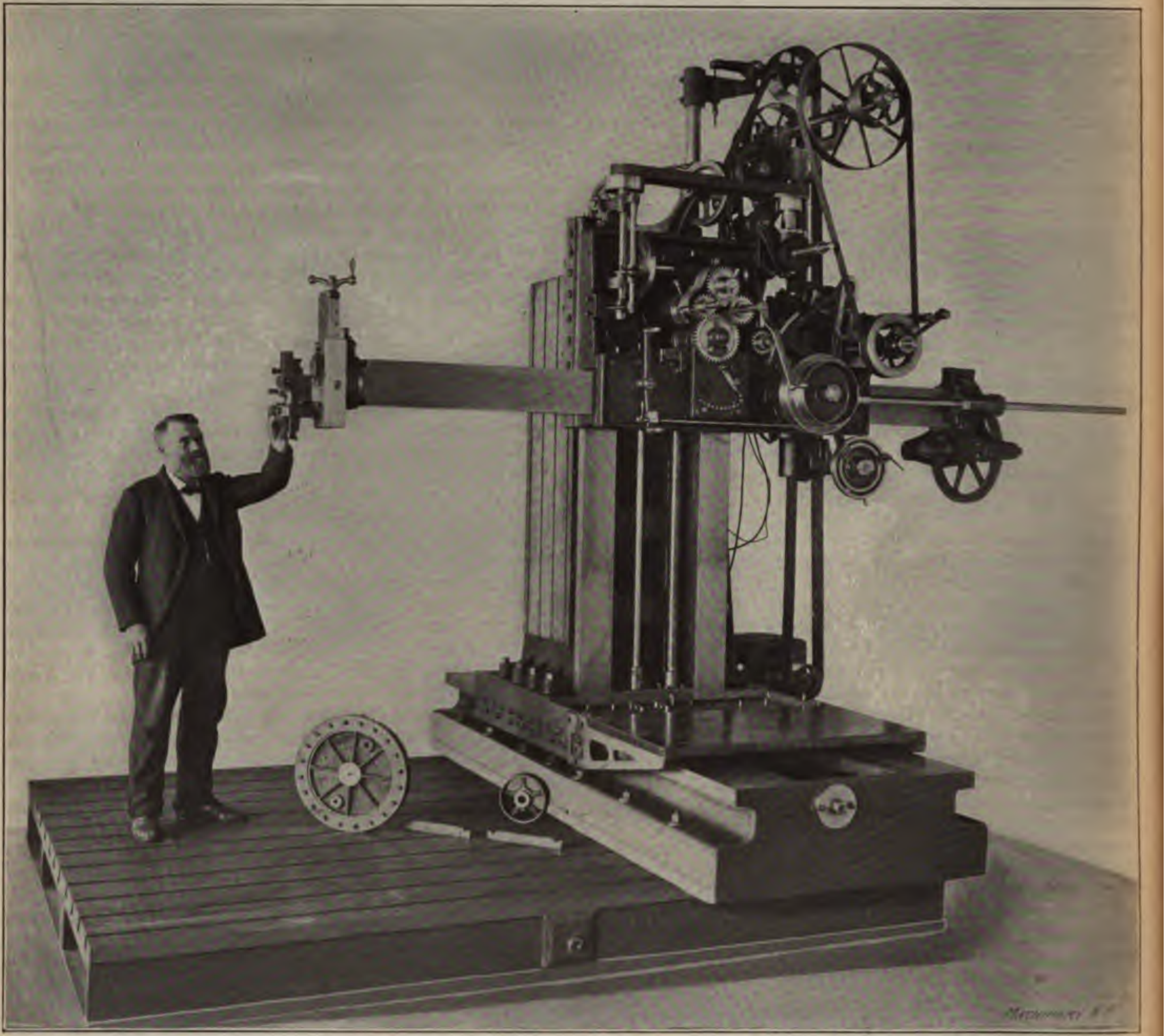

Fig. 1. Morton Traveling-head Draw-cut Shaper Weighing Sixteen Tons.

This machine has a floor plate 9'x10' 6", provided with T-slots, on which the work to be operated upon is placed. The bed is attached to the floor plate at right angles with the T-slots, and is heavily ribbed and cross-ribbed. A horizontally moving *vertical column is gibbed* and fitted to the bed, while the head carrying the shaper ram is capable of moving vertically upon the column.

This column is provided with square rail bearings, and upon it is located a vertically moving saddle or apron to which are attached the entire operating mechanisms of the shaper. The front side of the vertical column is also provided with a T-slotted plate. A brace can be placed between this plate and the work, thus holding the work rigidly when under heavy cuts. This column is also heavily ribbed and cross-ribbed, the metal being so distributed as to form the most substantial construction.

The vertical movement of the machine is 48 inches, logitudinal feed 78 inches, and it will admit of 6 feet between the ram and floor plate. Its total height is 13 feet and it weighs complete about 16 tons.

The ram is made of steel cast hollow, carefully fitted, and provided with wedge gibs for taking up wear. The machine obtains its reciprocatory motion through two friction clutches located on either side of the gearing and belted with an open and crossed belt from the countershaft, the ratio being such that the ram has a quick return of three to one. The friction clutches are positive in their movements and therefore the cutter will work close to a line and will carry a heavy cut. The shaper feed is operated by a self-driving friction. The feed screws are both stationary, the nuts revolving, they being fitted with ball-bearing thrust collars. It will be readily seen that by using the crank on the right-hand shaft, the apron of the shaper is made to raise and lower on the column, and by turning the left-hand squared shaft the column is fed longitudinally on the bed. By this arrangement both feeds are entirely under control of the operator. The stroke is adjusted by means of tappets on a circular disk, and there is a lever conveniently placed for the operator, for reversing at any point of the stroke. The driving gearing is all cut from the solid, and is encased and runs in oil.

An interesting and unusual feature of this machine is a milling attachment that is designed for facing in a plane perpendicular to the line of direction of the ram. This attachment consists of a steel arbor passing through the ram, which has a train of gearing at the rear end and which can be easily removed by the operator when it is not desired to use it. The cutter head used on the milling attachment is seen lying on the floor plate of the machine.

Power for milling is supplied through a cone pulley and bevel gears to a splined shaft which engages the gearing at the rear end of ram. It is belted direct from the countershaft and has two changes of speed. The feed when used for milling is taken direct from the cone pulley by belting to the encased mitre gearing and through the cone pulleys to the friction disk and can be regulated by raising and lowering the friction wheel which engages the disk and can be reversed by moving to the opposite side. Connected with the shaft of this friction disk are a worm and gear by which power is applied directly to the feeding shafts. It will be readily seen that this provides a continuous feed in either direction, enabling the use of a tool in the form of an ordinary milling head by which chipping strips and pieces can be faced from the sides of large castings. The machine is also provided with a friction clutch by which the countershaft can be stopped and started independently of the motor, and with this device, when moving the machine either vertically or horizontally by power, the machine itself remains idle. The vertical saddle is counter-balanced and power is applied through an endless belt, direct from the motor, which is so arranged that as the tool raises and lowers it does not affect the tension of the belts.

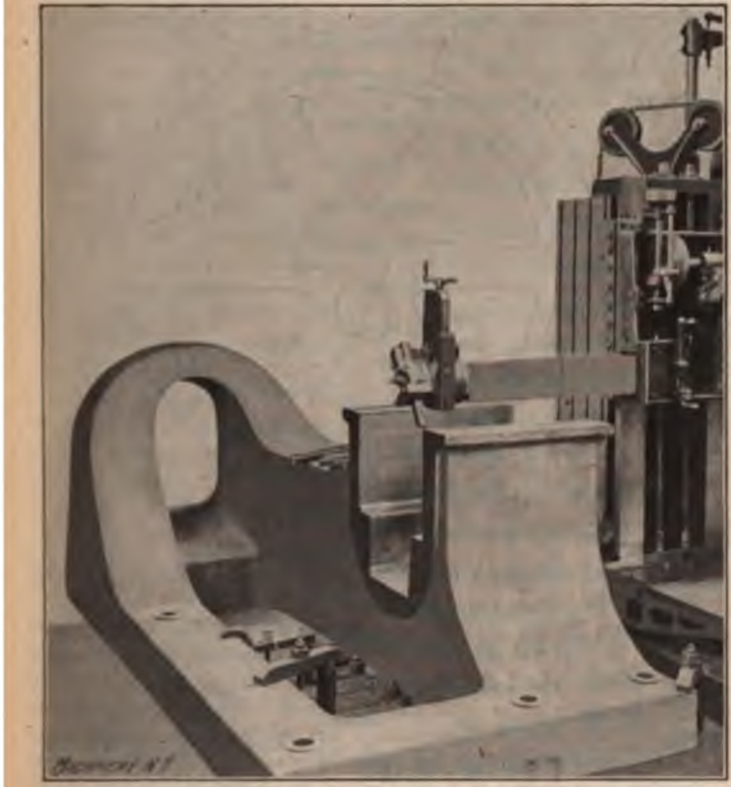

Fig. 2. Morton Shaper at work on a Bed Plate.

The machine is electrically driven, but can be furnished to be driven with a belt if so desired. It will be readily seen that the operator can adjust the stroke, control the feed, motor, and the entire machine from the platform made for this purpose.

As mentioned above, the machine is also constructed so that it can be easily detached from the bed, and can be used in connection with an ordinary floor-plate as a portable machine on heavy castings. It can also be provided with a small table of the ordinary box type, which can be bolted to the floor-plate and made of convenient height, upon which small work can be placed. In this way the machine will work successfully on small pieces as well as large. The floor-plate can also be constructed with a vertical floor-plate in connection with it, in a pit, so that by moving the machine to the front side of the floor-plate, heavy castings can be operated upon which could not otherwise be reached.

Cut 2 represents the shaper in the shops of the Hooven, Owens & Rentschler Co., at Hamilton, Ohio, at work on a large engine bed, planing out the pillow blocks. It will be readily seen that the pillow block may be fitted for the cap, and with the range of feeds, etc., the entire block may be machined with this tool. This illustrates only one of the many uses to which this machine can be placed.

* * *

An interesting feature of the present census compilation is the use of electric apparatus for tabulating the returns. From the schedules filled out by the enumerators, cards are punched on a hand machine to correspond with each person's age, color, employment, nationality, schooling, parents' nationality, etc., the location of the punched holes being determined by the conditions shown on the schedule. These cards are punched rapidly, the holes corresponding to the enumeration district being done automatically by gang punches. After these cards are punched (one being provided for each person), they are placed in the tabulating machine which automatically registers the cards on dials, each of which corresponds to some one condition, such as age, color, etc.

The manner in which this is operated is briefly described in principle. Imagine the cards laid out in a number of squares and each square corresponding to some condition which may be found by the enumerators and which is provided for by the questions asked. Corresponding to these squares is an equal number of plungers, having contact points at their lower ends. These plungers are held in a suitable frame which is depressed by a hand lever. When the card corresponding to any person's condition in life is placed in the machine and the plungers depressed, those corresponding to the openings punched out make electrical contact with a tiny cell of mercury beneath and thereby register on the dials for the contacts made. All the other plungers being prevented from making contacts, their dials make no record. In fact, if inconsistent holes are punched out by a careless operator, or if a card from a wrong district becomes mixed in with those for which the machine is set, the operator is at once given warning by automatic tell-tales. With one of these machines it is claimed that an expert operator can tabulate the returns for 50,000 persons per day.

* * *

## KEYS AND SPLIT HUBS.

### METHODS OF KEYING PULLEYS TO THEIR SHAFTS.

We have before called attention in these columns to methods of fastening pulleys, cranks, levers, etc., to their shafts, and have advocated the use of the split hub, clamped on the shaft by means of bolts in connection with a key. In view of two or three instances of this practice that have recently come to our attention, we will again refer to the matter, believing that whatever will help to abate the evil of keys, pulleys and cranks working loose is worthy of attention.

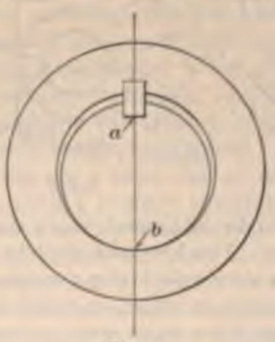

Fig. 1.

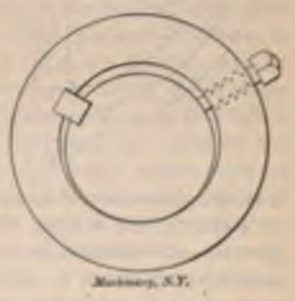

Fig. 2.

Very little fault can be found with a hub which is first forced onto the shaft and the key then carefully fitted so as to bear on the two sides of the keyway. Trouble begins when the shaft does not force into the hole and the tight fit is made by shaping the key so that it bears on the top and bottom, as shown in an exaggerated manner in Fig. 1. The shaft is then supported at two diametrically opposite points, a and b, and the torsional strains will easily work the parts loose.

We frequently see both a set screw and a key employed in the same hub, the former serving in part to clamp the hub to the shaft and the latter to keep one from twisting upon the other. The usual position of the set screw is either opposite the key, at point b in Fig. 1, or else it bears directly on top of the set screw, producing the same effect as though the key bore on the top and bottom and no set screw were used. One way is equally as bad as the other, and there is nothing to prevent the hub working loose in a short time; when, of course, the set screw will be tightened by some one and the process repeated. If the set screw and key must be used together, let them be placed as in Fig. 3, where the bearing of the shaft in the hub comes at three equi-distant points, the best arrangement to give a firm bearing.

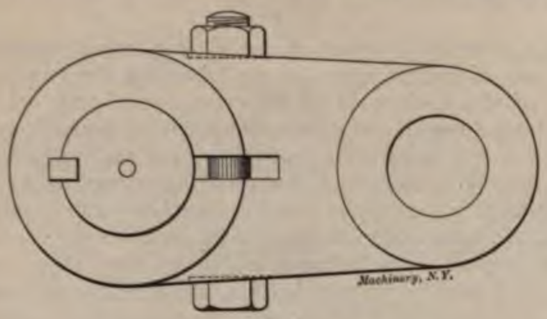

Fig. 3.

Any makeshift, however, for a solid, force-fit bearing of the shaft in its hub is not strictly what may be called good practice. The best fit is obtained when the shaft is turned large and either forced in the hub or the hub shrunk on the shaft. On the other hand, the work is often of such a character that neither of these methods is either satisfactory or desirable. Take the valve stems of Corliss engines, for example. These must sustain considerable torsional stress and their movement is intermittent, tending to work the valve levers loose on their stems. If the levers do not fit well enough to drive on to the stems with a sledge, it is quite certain that they will cause the engineer annoyance; and if, as is too often the case, these stems are finished by filing in the lathe, their surfaces will be so uneven that after driving the levers on and off a few times, they will be a free running fit on the valve stems. On the other hand, if the holes in the levers are reamed and the stems ground, the surfaces will be so perfect that they will wear indefinitely, but they will also be so unyielding that it is not commercially practicable to do the accurate work needed to make the fits as they should be. The Rice and Sargent Engine Co., Providence, R. I., at one time were fitting a number of 3-inch valve stems to cast-iron levers in which standard holes were reamed, and it was found that if the stems were ground ¼ of a thousandth, in excess of the diameter of the hole, this was all that could be allowed to enable one to drive on the levers with a sledge, to say nothing of being able to get them off again. No one, however, would pretend that quarter-thousandths of an inch are a success in commercial engine works.

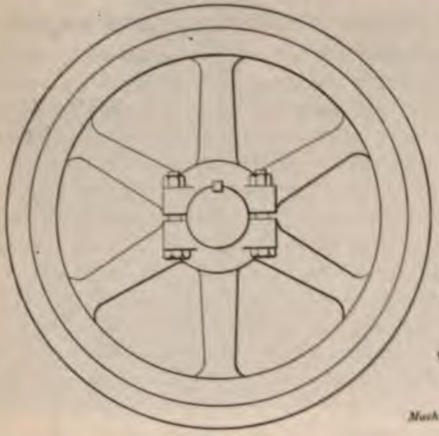

Fig. 4.

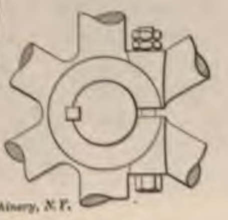

Fig. 5.

Such considerations as the above, coupled with the difficulty of forcing hubs, etc., on or off, has led a number of engine builders to clamp the hub to the shaft with bolts and then depend on the keys simply to prevent twisting, as suggested at the beginning. While such a method is a compromise, it is not a makeshift, and one's common sense will dictate where such construction is advisable. In Fig. 3 is a small crank or lever, which we have shown in a previous number. This is used by the C. W. Hunt Co., New York, and has also been adopted by the Lane & Bodley Co., Cincinnati, on their latest type valve gear, and by the Westinghouse Machine Co., Pittsburg, Pa., for the valve stem levers of the mammoth Corliss engines now in progress of construction for the Third avenue road of New York.

In flywheel work the Westinghouse Machine Co. adopt substantially the same system. One of their wheels is sketched roughly in Fig. 4, and will be seen to consist of a solid rim, with the hub split on two sides. This relieves the strains in the arms when the casting is cooling, enables the wheel to be easily put on or taken from the shaft at any time, and the bolts will clamp the hub so tightly that if the key is properly fitted there is no possibility of the wheel working loose. If any doubt the efficacy of the bolts in such a position, they simply need to recall that split flywheels of all sizes have always been used with success, and it is not a difficult matter to design the hubs of such wheels to have nearly as great strength through the hub joints as through any other part of the hub. In Fig. 5 is another form of flywheel hub upon the same principle, as made by the Ball Engine Co., Erie, Pa.

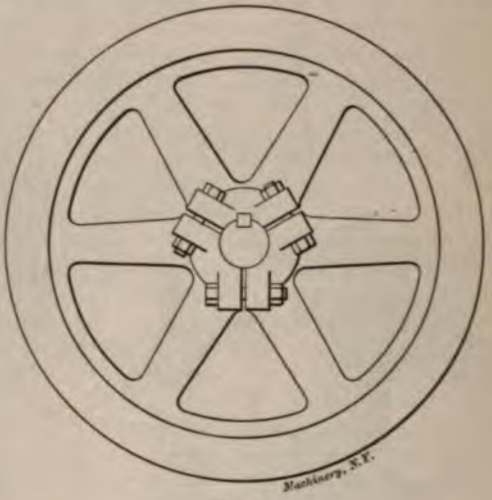

Fig. 6.

William Sellers & Co., Philadelphia, Pa., use the construction shown in Fig. 6 for the flywheels of their punching and shearing machinery. The hub is split into three sections and is clamped by three bolts on each side of the wheel. While this is a somewhat complicated construction, it has the merit of clamping the shaft evenly and of giving almost perfect relief to the internal strains in the arms of a solid wheel when cooling in the mold. A flywheel could scarcely have more severe work to do than one attached to machinery of this character and there is scarcely a place where a wheel would be more likely to work loose. If the split hub and key work well here, as we presume they do, there need be no hesitancy in applying the same or similar construction in almost any place where it is found convenient to do so.

* * *

There seems to be an effort on the part of many of the manufacturers in the cities of the soft coal districts to ameliorate the effects of the smoke nuisance to some extent. Prof. Benjamin, of the Case School of Applied Science, at Cleveland, has some chimney photographs entitled "To smoke or not to smoke," which show the results obtained with properly installed mechanical stokers and without any such appliance. Many firms are now introducing stokers, down-draft furnaces, etc., for the express purpose of reducing the smoke and with good success. It is proven beyond question that the better grades of soft coal can be burned in factory boilers without black smoke, except when cleaning fires. What is needed is regular firing and suitable means for bringing the gases and carbon passing off from the fresh coal intimately in contact with sufficient heated air to insure combustion.

## GAS ENGINE DESIGN.—8.

### TERS, THEIR CLASSIFICATION AND DESIGN.

E. W. Roberts.

s probably no subject in gas engine design that has
more trouble or annoyance to the builder, as well as
:r, of the engine than that of ignition. The writer be-
t as many engines have been unsuccessful because of a
ition device as from all other causes combined. The
that too early or too late ignition—either one—will
lling off in power and if ignition is interfered with from
, and for any length of time, the engine will stop alto-
\gain, the economy of fuel consumption depends, in a
sure, upon the proper timing of the ignition.

r that the reader may thoroughly understand the dis-
f the subject that is to follow, it will be necessary to
tline the various methods that have been in use and are
loyed, and to point out the inherent faults of each
Electric ignition, which is now becoming such a gen-
ite among the majority of gas engine builders, was the
: employed upon a commercial engine. Because of a
:rstanding of the principles involved, it was abandoned
n by means of a flame such as is familiar to those who
old slide-valve Otto engine. Later, ignition by means
ube was introduced, while in the interim many experi-
re made with other methods. These methods were
follows: In an engine experimented with by Mr.
lerk, the writer of the well-known book on gas engines,
slide containing a grate made of thin strips of platinum
re kept at a high temperature by the combustion of the
ne cylinder and retained sufficient heat from one charge
that which followed. This device was successful with
i which no explosions were omitted, but in a hit-and-
od of governing, the grate would cool down during the
es until its temperature was insufficient for ignition of a
g charge. Another method in which the operation and
ılties encountered were precisely similar to the above,
se of a long bolt screwed into the piston. The bolt was
y a slender one in order that it might reach incandes-
dily. A similar device employed was a bolt or pin pro-
om the cylinder head into the compression space.

estion which was made, but which the writer does not
s ever been carried out, was to use a small quantity of
as phosphuretted hydrogen and to inject this into the
on space at the proper time for ignition, the injected
g the property of taking fire immediately upon coming
with the air in the charge. A method which is in use
ral engines employing kerosene as a fuel, is to divide
ression space and keep a portion of it unjacketed so
l remain at a comparatively high temperature and act
the same manner as the familiar ignition tube. The
ube itself is nothing more nor less than a small cylin-
mber which is kept at a red heat by means of a flame
tside of the tube and which ignites the charge when a
f it is driven into the tube and comes in contact with
l point on the inner surface. The very latest method
n is one in which the fuel is not allowed to come in
ith the air until at the end of the compression stroke.
essing the air to a high pressure, it is raised in tem-
ıntil it is heated to a degree equal to the combustion
re of the fuel and the fuel, being admitted at the termi-
the compression stroke, burns as it enters. The method
n just described is that employed by the now well
eisel motor.

risk of controverting the statements of quite a number
gine builders, the writer would say that he believes that
gnition will, in time, be entirely superseded by electri-
ds. With the exception of the material of which the
mposed, the tube igniter has practically reached a stan-
, and as such it is used by the majority of those gas
ilders who still employ this method of ignition. It
f a tube having an inside diameter of from ¼ inch to
d which is from 4 to 8 inches long. This tube is usually
d with an outer cylinder or chimney nearly always
an innner tube of asbestos. The tube is heated by a
urner giving a flame of sufficient size to bring it to a cherry red heat. These tubes are variously made of wrought iron, of platinum, of porcelain or of a nickel-steel alloy. Wrought iron is the cheapest material when the cost of a single tube is considered, but, as they rarely stand more than two or three days of continuous use, they are very expensive in the end. Platinum tubes have a longer life than wrought iron, but are very expensive at the start, and, as compared with nickel-alloy or porcelain, they are comparatively short lived. The great difficulty with porcelain is its liability to crack when exposed to a sudden draft during the time it is at its high temperature. Nickel-alloy will last much longer than any other metal and has none of the objections credited to porcelain.

At the present time ignition tubes are very seldom made with a valve for regulating the exact time at which ignition shall take place. The timing of the ignition is regulated entirely by the amount to which the mixture must be compressed before the fresh charge can drive the products of combustion remaining from the previous charge far enough back in the tube to permit the fresh mixture to reach the red hot portion. The great objection to this method is that the timing of the ignition is very imperfect and is scarcely ever exactly twice alike. There are too many factors which will interfere with the proper timing. For instance, a leaky piston or valve, a change in the proportions of gas and air, or a slight alteration in the location of the "hot spot" on the tube, besides quite a number of other apparently insignificant factors will interfere with the action of the igniting device and alter the lead of the ignition.

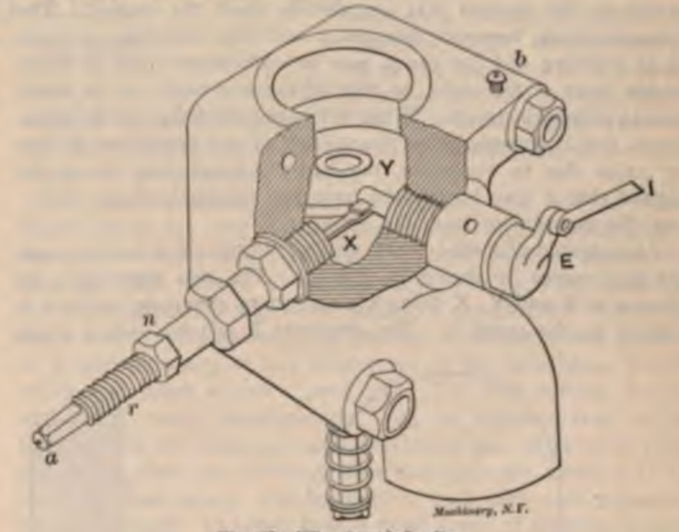

Fig. 35. Wipe-break Igniter.

Flame ignition will, in all probability, never be used again on a gas engine, for the simple reason that it is troublesome to manage on an engine having high compression, and, in a small engine, the percentage of gas used by the ignition device makes up a considerable per cent. of the total amount used for the engine. It is also quite likely to be blown out by any unlooked-for current of air or by any leak in the valve controlling the ignition. It has been practically abandoned for tube or electric ignition by all prominent gas engine builders. Electric ignition, which is the method now in most general use and which will probably supersede every other, with exception of the method employed in the Deisel motor, is the only one which the writer believes it is necessary to consider in this article. Electric ignition may be divided into two separate classes: the one in which the ignition is produced by interrupting a primary circuit flowing through a coil having a great deal of self induction, and the other by interrupting a primary circuit and employing this interruption to induce a current of high tension in a secondary circuit, producing a spark which will jump across an air space. The first method is that which is known as the make-and-break; the other is called the jump-spark method of ignition. The make-and-break method may be further divided into two classes: the one which is called wipe-break for the reason that one terminal is caused to rub upon the other and to suddenly let it go, the circuit being closed during the rubbing and a spark emitted just as the electrodes separate. The other has been called by several names, but the name which the writer thinks fits the case the best is the term "hammer-break." In this method, one electrode is forced hard against the other, closing the circuit, and then is suddenly withdrawn by means of a spring. Of the two, the wipe-break will give a more powerful spark upon an equal amount of battery power than will the hammer-break. The objection to the wipe break is, however, that the constant rubbing causes a great deal of wear and the electrodes need frequent adjustment while it usually necessitates a spring within the compression space and exposed to the heating effect of the combustion. This objection of having the spring within the combustion space has been overcome in some designs, but as a general rule the above statements fit the designs that are already upon the market. The hammer-break, however, does away with this objection, as there is no rubbing and the touch may be sufficiently light to avoid undue wear of the parts, so that adjustment need not be made except at long intervals. While it has been claimed for the wipe-break that it automatically cleans itself of any collection of soot or oxide due to corrosion, the hammer-break may be so designed that it may be cleaned from the outside without removing the mechanism from the cylinder.

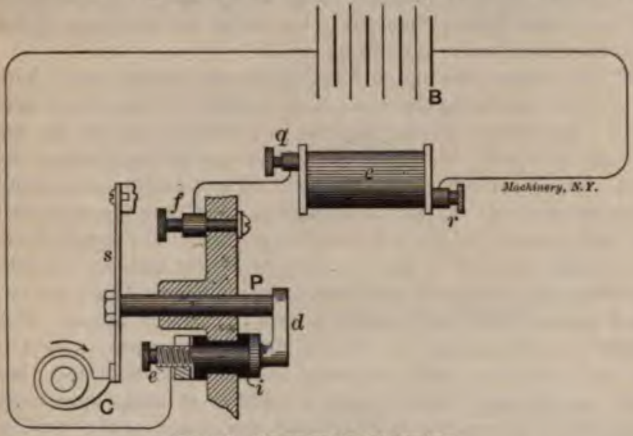

Fig. 36. Hammer-break Igniter.

An example of a wipe-break which is in use on a very successful gas engine is shown in Fig. 35. The two electrodes are shown at X and Y, X being the stationary electrode, while Y is rotated by the crank E. The electrode X is a flat spring which is deflected by the projection on Y at each rotation of the crank, a spark being emitted as the point of Y slips off of X. The electrode X is insulated from the frame of the engine and one of the wires is attached to it at A. The other wire is attached to b or to any other convenient point upon the body of the engine. Attaching one wire to the frame of the engine is usually termed "grounding" one side of the circuit on the engine. The adjustment of the electrode X is made by loosening the nut n and screwing up the threaded rod r to which the electrode X is attached. A good feature of this design is that the electrodes are placed in the inlet valve box where they are subject to the cooling effect of the entering charge. Much of the trouble usually caused by the spring X being within the combustion space has been overcome by this arrangement.

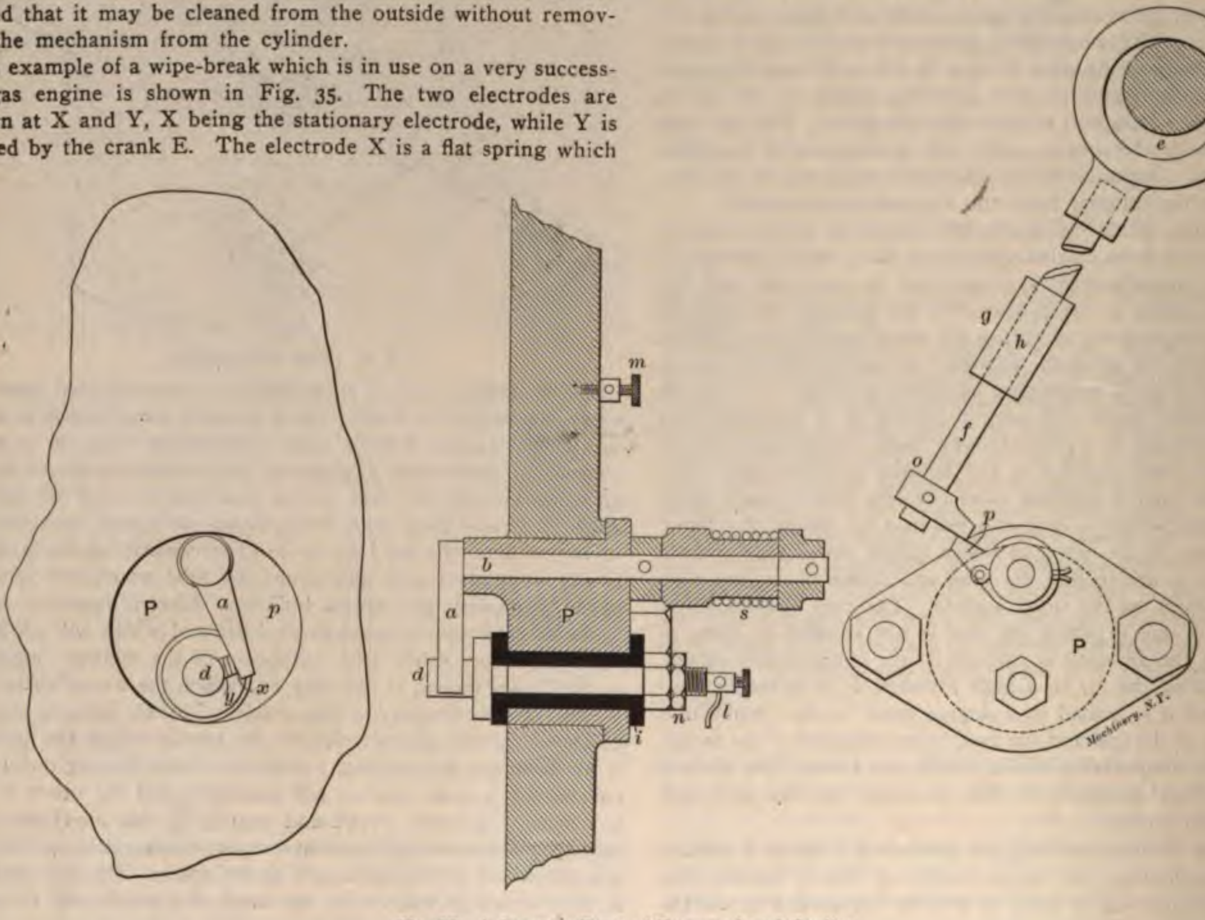

Fig. 37. A Common Form of Hammer-break Igniter.

The principle of operation of the hammer-break is shown in the diagram Fig. 36. In the figure, B represents the battery or other source of electrical energy as, for instance, a dynamo. The spark coil is shown at c and consists of a core of small iron wire about which is wound a coil of insulated copper wire of considerable current-carrying capacity, No. 14 or No. 16 B. & S. G. being the sizes usually employed. The movable electrode is shown at P and the stationary electrode at d. The electrode P is illustrated as being attached to a flat spring s which is depressed by the cam C carrying with it the electrode P and pressing it against d. After P has come in contact with d and is prevented from moving further, the portion of the spring which is nearest the cam is deflected, causing a pressure between P and d and effectually closing the circuit through the battery, the coil and the two electrodes. As the projection of the cam passes the end of the spring, the latter slips off, and electrode P is drawn quickly from contact with d, forming a rapid break and producing a spark between the electrodes on account of the breaking of the circuit. The circuit shown may be easily traced; one wire from the battery passing to the binding post on the end of d and the other to the binding post r on the coil, from the coil the circuit continues from the binding post q to the binding post f which is grounded upon the engine. The stationary electrode is insulated from the engine frame by mica or similar material as indicated by the full color at i.

The reader should note that the diagram in Fig. 36 is not intended to represent an actual device which is in use upon any engine. In fact, the writer does not advise the use of a flat spring at any point about a gas engine for the reason that, unless it is tempered with exceedingly great care and skill, it is apt to break without warning. The cleaning already spoken of may be effected from the outside of the engine by rotating the electrode P and at the same time pressing it against the stationary electrode d, it being, of course, necessary so to design the mechanism that this may be done.

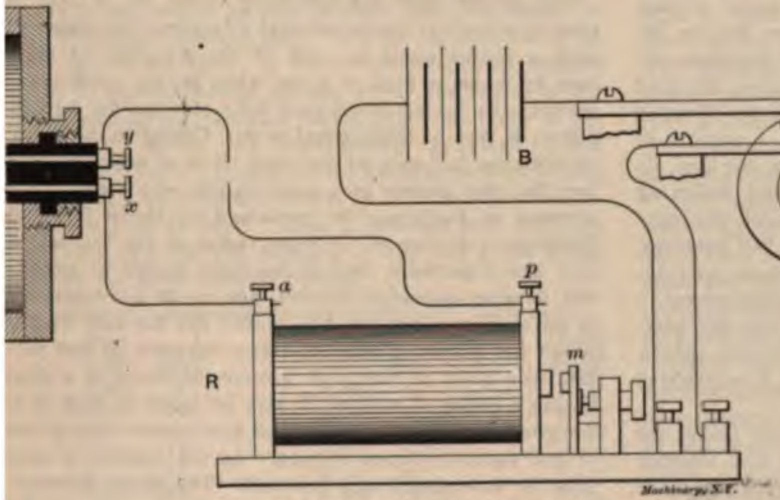

Fig. 38. Jump-spark Method of Ignition.

n of hammer-break which is used by a great many gas
ıilders is illustrated in Fig. 37, the stationary electrode
own at d, and being insulated in the usual manner from
ne by means of the insulation i which is fastened into
P by the nuts n and the plug is then bolted to the
head or some other convenient portion of the engine so
point d projects into the compression space. The mova-
er is shown in the several views at p and consists of a
an arm a. Two small rivets of platinum are inserted
of the electrodes as shown at x and y. These points
oyed in order to avoid the rapid destruction which would
e occur if they were not present and if contact were
tween the wrought-iron surfaces of the electrodes. The
attached to a shaft b which passes through a bushing to
ide of the engine and has upon its other end a hardened
jection z. About that end of this shaft which projects
outside of the engine, is a helical spring s, one end of
fastened to z and the other to the rod. Upon some
nt portion of the camshaft is an eccentric e carrying a
ich passes through a guide g, g being allowed to turn
pin located at the point h. On the end of f is a
steel projection o. As the cam rotates, the rod f is
the direction indicated by the arrow, the projection o
in contact with z, rotating it and carrying with it the rod
he electrodes are in contact, after which further rotation
ds the spring s increasing the pressure between the
and y. Further motion of the rod f allows o to slip off
z flies back owing to the tension of the spring and car-
it the rod b and the arm a, breaking the circuit with a
otion and producing a spark between x and y. The
m the battery and the spark coil are attached at l and m,
grounded at some convenient point upon the frame.

design of a device of this kind the following precautions
e observed: Make the projection d and the arm a so
have considerable body, in order that they may not be-
erheated by exposure to the charge when it is being
For the same reason the platinum points x and y are
y made of large diameter and quite short, say at least
n inch in diameter and not over 3-32 to an ⅛ of an inch
h. Wherever possible, the igniter points should be
the path of the incoming air in order to avoid over-
as it will be found a rather difficult matter to keep them
means of the water-jacket. Under no circumstances
ey be so placed that they are subject to the entire heat-
t of the exhaust as it passes from the cylinder, without
being made for keeping them cool.

mp-spark method of ignition is illustrated in Fig. 38,
follows: Current passes from the source of energy B
a switch S which is placed at any convenient point upon
shaft. From the battery and the switch, current passes
the primary circuit of the induction coil R. At a and p
n the terminals of the secondary circuit of the induction
which wires are led to the binding posts x and y of the
plug. In the figure is shown a magnetic circuit breaker
-operation of which is too well understood to need de-
in this article. This circuit breaker is not always used, for, in many cases, the designer depends on the induction of a single break in the primary circuit. The operation of the device is as follows: The primary circuit is closed at the proper time by the switch S and, in case the circuit breaker m is employed, the circuit is rapidly opened and closed producing a series of sparks between the points of the ignition plug at q. When no circuit breaker is employed, two sparks are formed, one when the primary circuit is closed by the switch and another when the circuit is broken. Of the two, the spark made when the primary circuit is broken is the more powerful and is that generally depended upon for igniting the charge. In some designs, but one of the terminals x y is insulated, the other side of the secondary circuit being connected through the frame, and the igniter point corresponding to that side is fastened to the igniter bushing. In case this method is used, it is customary to complete the primary circuit by means of wires and not to ground it, as it is claimed that if both circuits be grounded on the engine, perforation of the insulation in the coil is quite likely to result.

The great trouble with the jump-spark method of ignition is from two causes: one, the bridging of the gap at q by a deposit of carbon or other foreign matter allowing the secondary current to pass without sparking; and the other is the breaking down of the insulation due to the high tension of the secondary current.

The most practical method of avoiding the first of these troubles is to use only the requisite amount of lubricating oil for the cylinder and to use a quality of cylinder lubricant which will give the least deposit of carbon. The trouble from breaking down the insulation may be avoided to a considerable degree by the use of a comparatively low tension in the secondary circuit. It is not necessary to use a pressure in the secondary circuit which will jump across a long gap. The best results, in the opinion of many experimenters, may be obtained from a fat spark which will jump across a maximum gap of ⅜ to ½ inch and to so place the igniter points that they are about 3-32 to ⅛ of an inch apart. For insulation, both lava and porcelain have been used. In either case, a good grade of material should be employed and the insulation should be thick enough to avoid breaking from shock, or piercing by means of the secondary current.

* * *

## SHOP TERMS ILLUSTRATED.

WATER FINISH.

# BALL BEARINGS

## NOTES ON THE NUMBER AND SIZE OF BALLS TO BE USED IN BALL BEARINGS.

D. T. Randall.

Recently the writer had occasion to look into the subject of ball bearings, particularly in regard to the relation between the size and number of balls used and the pressure or load to which the bearings may be subjected. A search through available engineering literature for some recognized standards of practice and for results of experiments on ball bearings under various conditions, resulted in finding comparatively few articles on the subject, except such as relate to the design of bearings, under light loads, to prevent friction from the twisting or spinning motion of the balls. Of these there are many, and the theories are almost as numerous as the writers. However, a number of important facts and principles were collected from the few articles found on the subject under consideration, and, believing that such a collection cannot but be of value to those who may as yet have had little experience in the design of ball bearings, the writer submits the following notes, with no claim to originality unless it be in the matter of selection and arrangement.

The chief advantage to be gained by the use of the ball bearings are less frictional resistance, and very high allowable speeds. These facts are so familiar and have been so often demonstrated by experiments as to need no further remarks.

In designing a ball bearing one knows, or should know, the greatest pressure to which it will be subjected and also whether the diameter of the ball races will be limited by other parts of the design. Having this data, there remains to be determined the size and number of balls and the best form of bearing surfaces for the given conditions. In general we know that large balls are most efficient, but extreme cases of loading or other conditions may make it desirable to know the smallest size and number of balls that may be used and yet have the bearing reasonably efficient and durable. In Kent's Mechanical Engineer's Pocket-Book may be found the following statements: "Balls should be of the largest possible diameter which the space at disposal will admit of; any one ball should be capable of carrying the total load upon the bearing; the frictional resistance is proportional to the load; friction is inversely as the diameter of the balls, probably as the square of the diameter; friction is independent of the number of balls and of the speed." The importance of ball bearings is gaining recognition, and recently experiments have been carried on to determine the relation between the pressure on the bearing, the number and size of balls and the form of the ball races to secure an efficient bearing; also on the strength of the individual balls to resist crushing.

Mr. J. F. W. Harris, in Transactions of American Society Mechanical Engineers, 1899, gives results of tests on steel balls of several makes, which show that we may expect a one-fourth inch ball to break under a load varying from 5,500 pounds to 8,600 pounds, according to the make of the balls; a three-eighths inch ball to break under loads from 10,500 pounds to 14,900 pounds, and a half inch ball, under loads from 13,000 pounds to 40,000 pounds (range of values for four makes). In this connection the author makes an interesting statement to the effect that few of the common tool steels can be hardened sufficiently to resist indentation when pressed upon the balls.

Owing to the wide range of values obtained it is difficult to fix a value for the various sizes. For the purpose of the designer, the strength of balls of the same make may be taken as directly proportional to the square of the diameters of the balls. The most complete article on ball bearings that has come to the notice of the writer is in Die Maschinen Elemente, by C. Bach, who is recognized as the best German authority on machine design. As an introductory remark the author says that it is difficult to secure an even distribution of pressures on the balls and that this fact must be taken into account when designing ball bearings. The following general formula is given: $P = KId^2$.

In which $P$ = pressure on the bearing,
$I$ = the number of balls under pressure,
$d$ = the diameter of the balls,
$K$ = a variable coefficient.

As shown by the formula, if the same size of balls be used, the allowable pressure depends directly on the number of balls. The pressure that may be sustained by one ball under good conditions is directly as the square of the diameter; that is, one ball one-inch in diameter is equivalent to four balls one-half inch in diameter. This fact may be explained as follows: All materials are more or less elastic; a large ball will be depressed less deeply into its track before securing a sufficient bearing surface than a small one. It is to lessen this action between balls and their bearing surfaces, as well as to overcome the inaccuracies of these parts, that large balls are recommended.

The author gives the following values for K: (a) for hardened steel balls in hardened steel grooves of the shape of an arc, with a radius equal to 9/16 of the diameter of the ball; K may be taken as high as 4,500, when all the conditions may be perfect; (b) for hardened steel balls between flat hardened steel plates; K may be taken equal to 90. Owing to the small contact between the ball and the flat plate, K is of necessity small. The fact that the groove of a small radius will permit so great an increase of load may be explained as above for large balls. Evidently a groove of the same radius as the ball will endure a very heavy pressure, but, as has been shown by experiment, it will develop excessive friction, due to its unavoidable twisting in its motion about the ball circle: (c) for cast iron balls between flat plates; K may be taken between 30 and 50; (d) for cast iron balls in cast iron grooves in form of a circular arc having a radius of 9/16 d; K may be taken as high as 1,800 under good conditions. The author also treats of the proper forms of ball races to lessen friction. As the contact is lessened, K must be correspondingly lessened. The above formula enables one to determine the smallest size of balls to be used in order to secure an easy running bearing in which the wear on the balls and grooves will be small. In all cases where circumstances will permit, balls of larger diameter may be used to lessen the frictional resistance. In many lightly loaded and high speed bearings, balls of such a size and number are so used as to reduce the load on each ball to a mere fraction of that which might safely be carried.

In a series of tests on the friction of end-thrust ball bearings, published in "The American Machinist" January 5, 1899, Mr. Thomas Hill shows results in favor of flat plates for bearing surfaces. The V-grooves or four-point bearings gave about 11 per cent. higher frictional resistances. Circular grooves, with a radius equal to that of the balls, gave high resistances on light loads when compared with those of flat plates, but under heavy loads there was not so wide a difference. In the same periodical Mr. Reynold Janney gives results of experiments to determine the necessary angle between two surfaces which are in contact with the ball, in order that the ball may be crowded back to its proper path, against its own weight, in case it should leave that path by reason of looseness of the bearings. The conclusion arrived at is that the angle should never be less than 25 degrees. This conclusion is of such importance that it must not be disregarded in the design of ball bearings. Fig. 1 illustrates the requirements for a three-point bearing, each of the angles alpha and beta being equal to or greater than 24°. After deciding upon the number and size of balls to be used, the diameter of the circle passing through the centers of the balls should be found. Or if the diameter of this circle be limited between certain sizes, then the proper number and size of balls must be found to correspond. The relation between the ball circle and the number of balls of a given size may be found graphically by a few trials on the drafting board, but may be obtained more accurately by mathematical solution from the

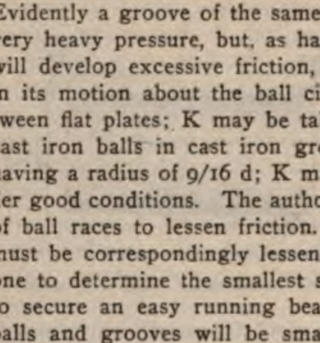

Fig. 1.

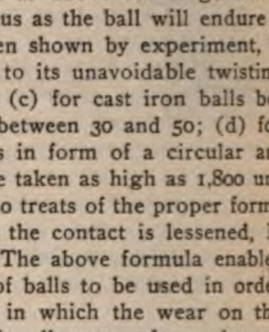

Fig. 2.

fact that the radius of the ball equals the radius of the ball circle multiplied by the sine, of 180 degrees, divided by the number of balls. This may be seen by reference to Fig. 2. Let n = number of balls. R = radius of the ball circle, r = radius of the ball. Then $r = R \sin a$ or $R = \frac{r}{\sin \frac{180}{n}}$ the angle a being equal to $\frac{360^\circ}{2n}$. $D = 2R$. This result is the exact radius of the circle on which the centers of the balls will lie when their surfaces are in contact. It is desirable to allow some space between the balls, say .005 of an inch between each two balls. In general the total space allowed should not exceed one-fourth the diameter of one of the balls. If the total clearance be decided upon, it can be approximately allowed for in the radius of the ball circle by adding to the exact radius one-sixth (1/6) of the clearance desired. Below is a table giving diameters of ball circles for one-inch balls. Diameters for other sizes of balls may be obtained by multiplying the results in the table by the diameter of the balls to be used. Thus, if one-half inch balls are to be used, take one-half the diameter of the ball circle found in the table for the given number of balls.

**Exact Diameters of Circles passing through the Centers of 1-inch Balls.**

| No of Balls. | Diam. of Ball Circle. | No. of Balls. | Diam. of Ball Circle. | No. of Balls. | Diam. of Ball Circle. |
|---|---|---|---|---|---|
| 6 | 2,000 | 15 | 4,810 | 23 | 7,345 |
| 7 | 2,310 | 16 | 5,125 | 24 | 7,662 |
| 8 | 2,612 | 17 | 5.440 | 25 | 7.978 |
| 9 | 2,923 | 18 | 5,758 | 26 | 8,296 |
| 10 | 3,236 | 19 | 6,075 | 27 | 8,615 |
| 11 | 3,548 | 20 | 6,394 | 28 | 8,934 |
| 12 | 3,864 | 21 | 6.710 | 29 | 9,249 |
| 13 | 4,179 | 22 | 7,027 | 30 | 9,566 |
| 14 | 4.494 | | | | |

To design the bearing after having found the above relations, it is first necessary to locate the centers of the balls on the drafting board at the distance from the axis of the bearing equal to the radius of the ball circle, as found by the table or graphically, and then design the bearing parts about the balls as in Fig. 3. The design of the bearing parts, to prevent friction and the consequent wear due to the twisting and spinning of the balls, is accomplished by making the parts of such shape that each ball will take up a constant individual axis about which all points in its surface tend to rotate, this axis being in motion, one end always pointing to a fixed point in the center of the shaft or axle of the bearing. The various methods of obtaining these results are not within the scope of this paper, and the reader is referred to the many articles which have appeared in recent technical literature.

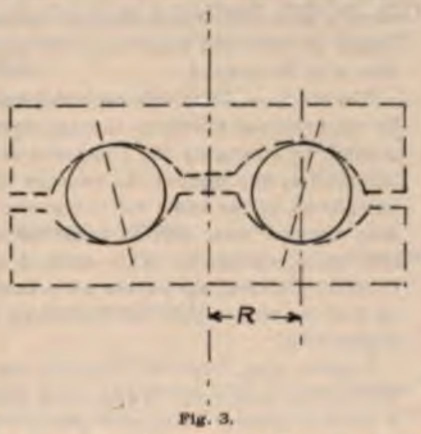

Fig. 3.

* * *

## BOATING ON THE OHIO.

To an eastern mechanic there is no more interesting feature in the Central West than the light draft river boats. Those who attended the Cincinnati meetings of the A. S. M. E. and went on the excursion down the Ohio River had a good opportunity to study the marine architecture of that section, and many commented on the apparent discrepancy between the shallow draft and the spacious cabin and deck room of some of the boats.

These vessels draw from one to two feet of water only, and, of course, all freight must be carried above deck. The actual tonnages, therefore, are not as great as the imposing appearance of the craft would indicate, because the deep-draft vessels with which we contrast them carry immense cargoes below the water line, besides the freight, live and otherwise, on the decks.

The chief aim of the builder appears to be to make a boat as flexible as possible—something that will squirm over obstructions about as a snake overcomes obstacles in his path. According to all accounts it is entirely possible for a boat to navigate a considerably less depth of water than its own draft; in fact, it is said they will navigate a heavy dew. While we have not seen it done, it is asserted that to float over any ordinary obstacle the bow is lifted as high as possible by tackle attached to heavy poles driven alongside into the river bottom. The engines are then reversed full speed, which rushes the water ahead, upstream; and when the wave returns the engines are driven ahead and the boat thus rides the wave and mounts the obstacle. The machinery is peculiar to itself and has been developed by years of experience with the trying conditions of river navigation. It is hard to make an eastern man believe that the valve gear and other details could not be advantageously modified, but western men refuse to admit that any other type would do the work at all and we presume that if shallow rivers exist in Jupiter or Mars, they would expect to find that substantially the same class of machinery had been developed for the boats there as here, so perfectly does it fulfil the conditions.

Both stern and side-wheelers have horizontal engines with very long stroke, which are capable of running cool however much their flexible foundations may twist or deflect. Cams are employed instead of eccentrics, which give an intermittent motion and fixed cut-off to the gear. Poppet valves are used and they are operated by a tappet motion and reversing gear, similar to one of the earliest locomotive reversing gears. There are two engines on each boat which are independent except for connections calculated to keep the two valve gears in unison. On some of the engines the gear is simple and on others very complicated. On all of them it is noisy.

The stern wheelers have hexagon wheel shafts of wrought iron. The arms to which the paddles are attached are bolted to cast-iron spiders or hubs, with rough hexagon holes to fit the shafts, and they are attached to the shafts by wedging in place. The connecting rods are as likely of wood as of iron and in any case are so long that they must be trussed to prevent deflection and vibration.

The boilers as well as the engines have characteristics of their own and are a modified form of the ordinary horizontal boiler, but without the brick setting. The newer boilers generally have two or more flues. The shells have a sheet metal covering, lined with fire brick, and the covering is far enough from the boiler to leave a passage through which the gases from the fire box can pass around the outside of the shell, before returning to the uptake, through the flues. About 125 pounds pressure are carried and it is usual to have a float water-level indicator in place of a water glass.

The waters of the Ohio rise and fall to such an extent that none but floating wharves are possible and ordinarily no wharf is needed at all. The boat runs close in shore, and the gang plank, which is ever ready, suspended from a derrick on the forward deck, is swung out far enough to rest on the dry land, while the hawser is made fast to any convenient tree, or perhaps not made fast at all.

* * *

Two or three times we have called attention to the practice of cutting spiral oil grooves in the shafts and journals of a machine instead of in the bearings in which the shafts run. Two months ago we reported that this practice was followed by the Bullard Machine Tool Co., Bridgeport, Conn., and we have also observed that it is practiced by a number of other builders. While we believe this is the most satisfactory plan for oil grooves, for many classes of work, its greatest advantage is realized in extremely heavy machinery. Oil grooves will fill up and in heavy machinery they will not only fill up with dirt, but with particles of the soft metal of which the boxes are generally made. This is particularly the case when the bearings are new and the shafts are seating themselves. At that time the most oil is needed and it is the most difficult to get oil to the bearings because the grooves are filled up during the first few day's run. The writer noted recently a rolling mill engine of several thousand horse-power that was being built by Mackintosh, Hemphill & Co., Pittsburg, Pa., in which grooves in the shaft were specified by the engineer contracting for the engines. In work of this class it is almost impossible to lift the shaft in order to remove the shells for cleaning, but where the grooves are in the shaft they can not only be cleaned easily, but they distribute the oil more thoroughly.

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# MACHINERY

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## JULY, 1900.

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| 1899. | | 1900. | | 1900. | |
|---|---|---|---|---|---|
| August | 17,150 | January | 20,000 | June | 27,500 |
| September | 18,000 | February | 20,500 | July | 22,000 |
| October | 17,500 | March | 25,000 | | |
| November | 17,750 | April | 21,500 | | |
| December | 18,500 | May | 21,500 | | |

## A NEEDED SHIPPING LAW.

The general public is probably not aware of the enormous annual loss of lives and property at sea due to the wrecks of what are known as "tramp" steamers. Tramp vessels are those having no fixed sailing routes, but depending on shipping cargoes from any port to any other port and there again securing a cargo which will yield a profitable monetary return. In some ports they are disappointed in securing cargoes and have to make long trips in ballast. Often the ballast is quite expensive, as it represents considerable labor cost for the mere handling, to which often must be added charges for the material even if nothing but broken rock. Under such circumstances many commanders take on board only enough ballast to submerge the propeller to about half its depth. The result is that the propeller thrashes the water in a manner that is very destructive to the shaft and the adjacent plates of the vessel. The continual bending strain caused by a partially submerged propeller will eventually break any shaft whether large or small and whether made of the best steel or ordinary wrought iron. The only difference found in the materials composing the shaft or its size, is that the time limit for the best materials and larger shafts is longer than that for the weaker ones.

Almost all countries now have maritime laws prohibiting the sailing of all vessels loaded beyond a certain water line, as it has been found necessary to have such laws to defeat the plans of unscrupulous parties who would not hesitate to dispose of ships and cargoes to the maritime insurance companies by loading their vessels excessively so that they would be likely to founder in the first storm encountered. A law which would also prohibit the sailing of all steam vessels without sufficient lading to immerse the propellers, is equally as needful, as the dangers of wreck and loss in mid-ocean from failure of the machinery, are nearly, if not equally, as great as those arising from excessive cargoes.

* * *

## A CHANCE FOR GREATER USEFULNESS.

The departments of experimental engineering in the various colleges and technical schools have been developed to such an extent that they are prepared for any of the problems in mechanics that are capable of solution through experiment. With so many well-equipped laboratories, all of them doing good work, it is evident that there is the opportunity for a large amount of investigation that would be of great value to engineers, designers, etc. As a matter of fact, however, the results of their experiments are not available to any such extent as they ought to be. There is no certain and regular channel through which the results of tests can be reported and while they are sometimes brought to light through the proceedings of the engineering societies or through the publications of the colleges themselves, most of them are never heard of at all.

In the next place, many of the experiments are practically duplicated in the different laboratories. While this is necessary to a certain extent, because of the educational value of certain standard tests, it is apparent that there must be considerable waste energy in conducting special tests so long as each laboratory works independently of the others and in a measure duplicates their work. Few laboratories, moreover, can undertake to carry a series of experiments to completion within a reasonable length of time and their work therefore lacks the completeness that is to be desired.

The work of these laboratories, we would suggest, measured by its practical utility to the engineering public, could be improved by arranging for concerted action, so that a number of laboratories throughout the country could be engaged in different phases of the same subject at the same time. After a suitable interval these results could be collated and prepared for convenient reference. This method of working should be arranged by mutual agreement as to subject, system of testing, etc. so that no tests would be duplicated and the results would be comparable.

A better plan, however, might be for the American Society of Mechanical Engineers to appoint a committee to lay out a series of tests of general utility and arrange the details for its successful prosecution. The committee could then invite the colleges having suitably equipped laboratories to conduct some part of the series of tests, if they cared to do so; and it is safe to predict that the chairman of the committee would be able to present one of the most valuable papers that has been published in the proceedings of the society. It would be a paper that would arouse an unusual amount of interest because of the large number of people personally interested in it and it would, in our opinion, do as much as any one thing to bring those who are inclined to be sceptical about technical schools into full sympathy with them.

If such papers, covering their subjects with a fair degree of completeness, were presented from year to year, they would increase the value of the society's publications more than several papers containing reports of tests upon different branches of different subjects. The papers would be looked forward to by many readers and would be carefully preserved by them.

It is generally admitted that in educational work it is better to take a student through one subject thoroughly than to give him a smattering of many. The same principle holds in disseminating information among the public. It is better for them to have complete information upon one subject, in convenient form for reference, than for them to be obliged to seek for information from several sources, and then find, perhaps, that the available information is still incomplete.

# AMONG THE SHOPS.

## A FEW SNAP SHOTS, PHOTOGRAPHIC AND OTHERWISE, OF THE HAMILTON MACHINE TOOL COMPANY'S WORKS, HAMILTON, OHIO.

ARTHUR LETHERBY.

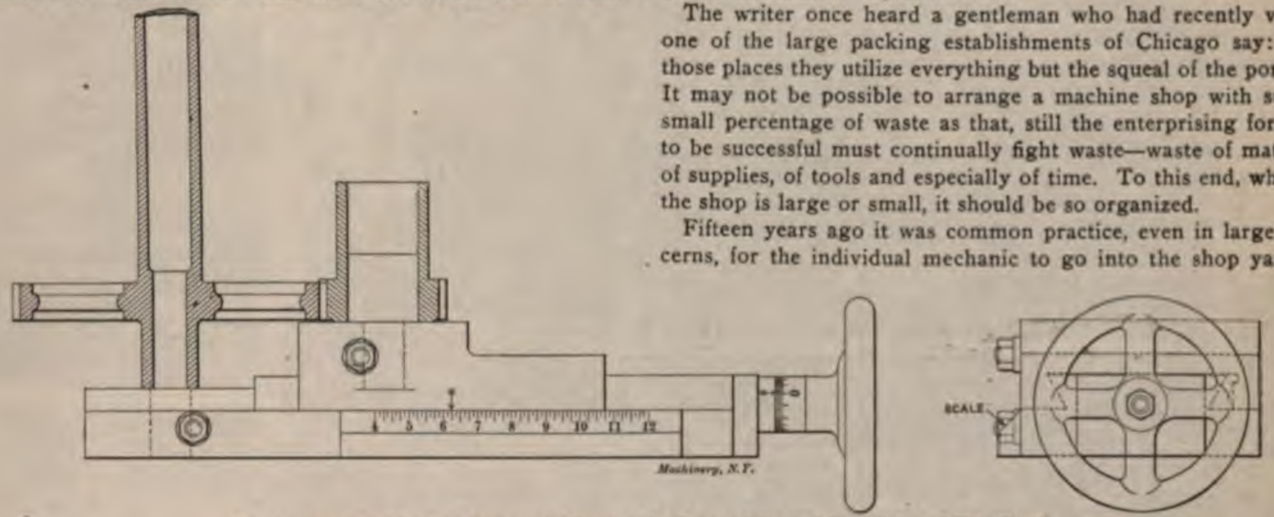
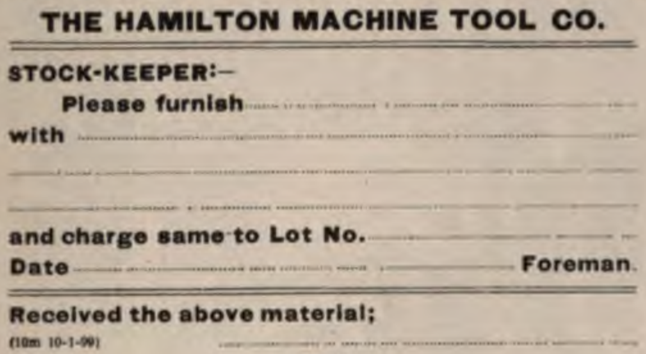


Fig. A. Spur Gear Testing Device, for Testing for Eccentricity and for Thick and Thin Teeth.

One whose vision and experience have been centered east of the Allegheny Mountains and who has been taught to believe that "Whatsoever things are true, and right, and of good report" in machine tool construction must be necessarily rooted and grounded in "Yankeedom" (and there is a good deal of truth in that creed) is pleasantly surprised and possibly benefited by a leisurely trip, commencing at Pittsburg and following, not too closely, the Ohio Valley. Here he may witness the virile growth of many modern manufacturing plants that have sprung into existence during the last decade or so, as well as some very fair specimens of what I think "Chordal" calls "shopitecture," some of which have been illustrated in this valuable paper from time to time. Time would fail me, however, to write of the many modern shops that are to be found in what is known as the Cincinnati district, and of which Hamilton is no mean factor, or of the many excellent productive organizations therein. What brief space I have to consume is to be used in a short sketch of the Hamilton Machine Tool Works, and while it is not presumed that anything new will be noted, still something of interest may be developed that may be useful to the young "technic" who has "hitched his chariot to a star" and might possibly overlook some such mundane things as a well kept casting shed; and yet it is a fair guess that such a shed would save him much more nervous force than a knowledge of the equation of the planets in his position of foreman or superintendent.



**THE HAMILTON MACHINE TOOL CO.**

**STOCK-KEEPER:—**

**Please furnish** ..........

**with** ..........

..........

..........

**and charge same to Lot No.** ..........

**Date** .......... **Foreman.**

**Received the above material;**

(10m 10-1-99) ..........

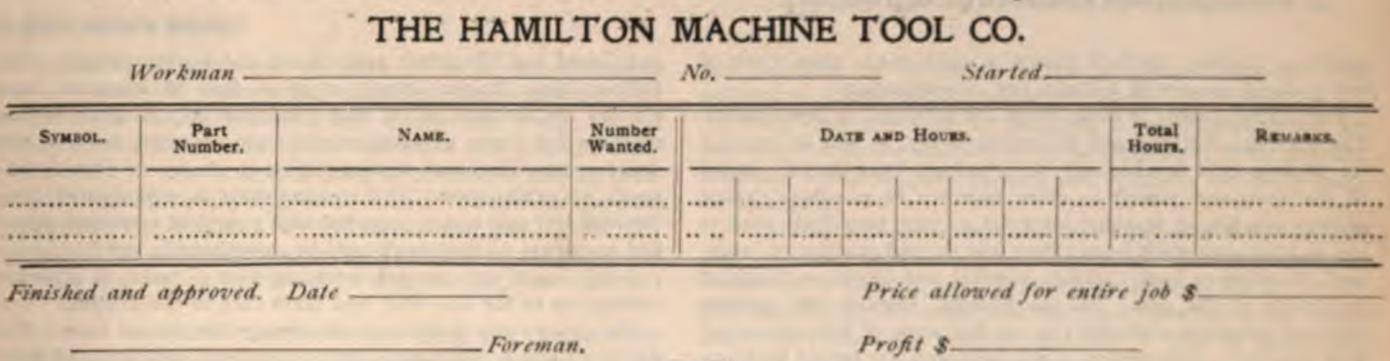
Fig. B.

The writer once heard a gentleman who had recently visited one of the large packing establishments of Chicago say: "In those places they utilize everything but the squeal of the porker." It may not be possible to arrange a machine shop with such a small percentage of waste as that, still the enterprising foreman to be successful must continually fight waste—waste of material, of supplies, of tools and especially of time. To this end, whether the shop is large or small, it should be so organized.

Fifteen years ago it was common practice, even in large concerns, for the individual mechanic to go into the shop yard or cleaning shed and sort out the parts he required, put on his initials with a piece of chalk and try and work up a "stand in" with one of the helpers to deliver the same to his lathe or planer as the case might be.

All this go-as-you-please method is now done away with and various plans are adopted for the distribution of raw material. Our plan is briefly this:

When castings come in from the foundry, they are first weighed in bulk as so many thousand pounds received that day, and credit given the foundry or foundries as the case may be. They are then assorted by the man in charge and checked up to see if the order is delivered in full. Any shortage is noted and a memorandum given the head stockkeeper, who then compares it with the foundry list and notifies them of such shortage. If the castings are not immediately required in the shop, they are placed in bins properly labeled and the number of pieces marked on the face of the bin, as for instance: E. L. 263-29, which, translated, would read, Engine Lathe, pattern number 263, 29 pieces. The size and style of the machine is denoted by the pattern number, each machine taking the number between given limits; for instance, 14" Lathe 0 to 200, 16" Lathe 250 to 450 and so on. Upright drills are denoted by pattern symbols L. and L. L., radial drills by R. D., sensitive drills by S. and so through the entire line. Thus at a glance the stockkeeper or foreman can tell just what pieces are complete for a given lot of machines and order them delivered accordingly. It is obvious that to profitably manufacture tools in lots of from 50 to 150 a large stock of raw material must not only be carried, but the different parts must be machined at the one setting up of the machine tool, as



*Lot No.* .......... *Job No.* ..........

THE HAMILTON MACHINE TOOL CO.

*Workman* .......... *No.* .......... *Started* ..........

| SYMBOL. | Part Number. | NAME. | Number Wanted. | DATE AND HOURS. | | | | | | | | Total Hours. | REMARKS. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |

*Finished and approved. Date* .......... *Price allowed for entire job $* ..........

.......... *Foreman.* *Profit $* ..........

Fig. C.

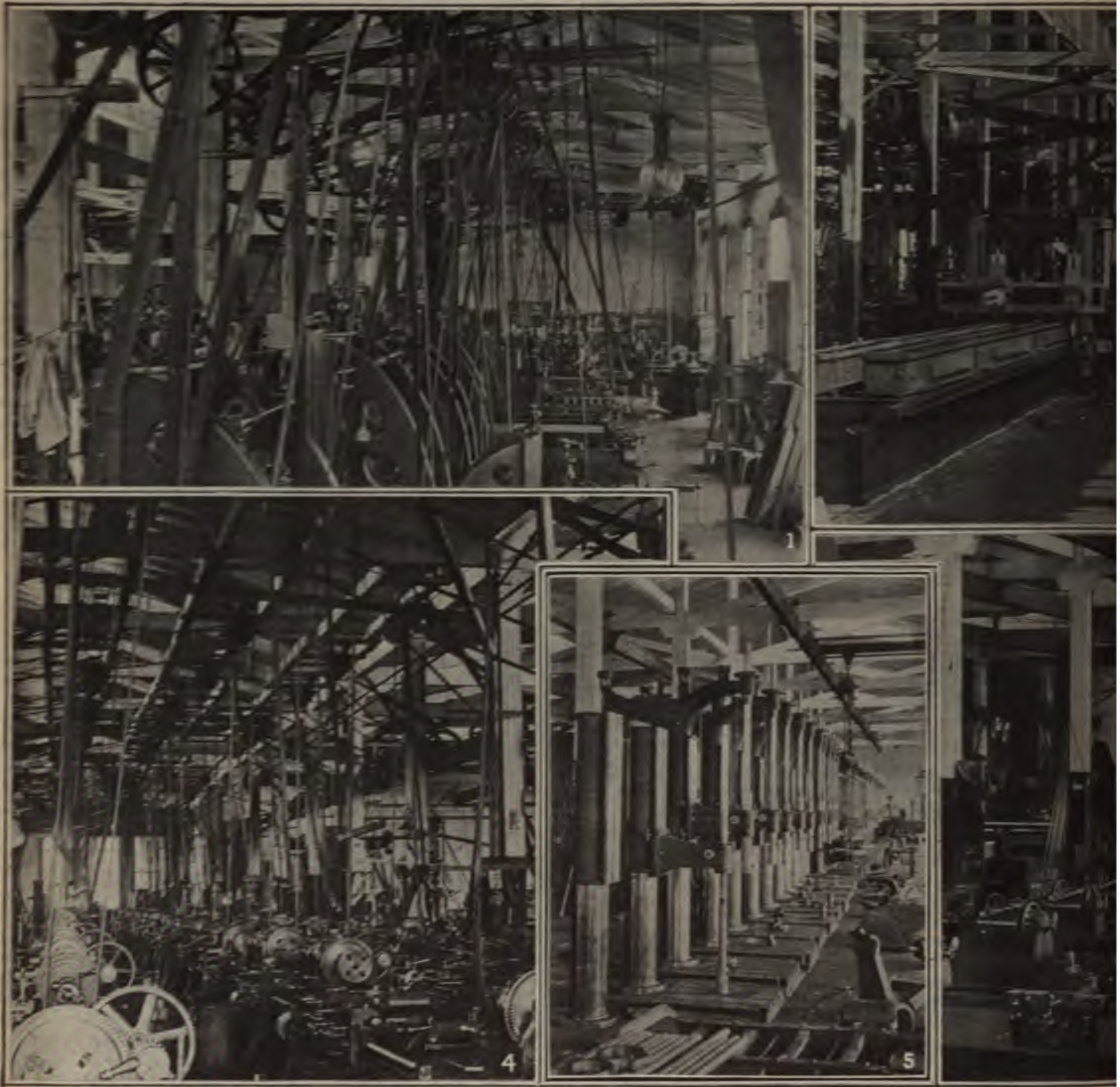


Fig. 1. Planing Department, with gear cutting and milling machines in the background. The planers are served by a tramway and small planers or shapers are placed between the larger tools, facing a strong east light.

Fig. 2. Main aisle, showing 31-ft. planer planing six 18-inch x 10-ft. lathe beds in foreground on the left. This view was taken with a wide angle lens and does not give a correct impression of the length of the shop.

Fig. 3. Stock Room. Size 43 ft. x 30 ft., contains 800 compartments; central rack extends from floor to ceiling; upper compartments reached by central stairway and gallery running around the room.

Fig. 4 Lathe Department, showing arrangement of tools to economise floor space.

VIEWS FROM THE HAMIL

otherwise nothing much is gained in time and a large stock of raw material is carried without any compensation.

The machine tools in these shops are arranged in departments. The turning, chucking and flat turret lathes, as will be seen by the photographs, are laid out in three long lines the full length of the shop and placed as close together as possible. Arbor presses are placed at short intervals so that very little time is lost in removing work from arbors and the old practice of "touring" the shop to hunt a sledge-hammer and blocks is relegated practically to the past. All the planing, shaping and slotting tools are placed in a double row so that work of that class is all kept together. The planes, as will be noted, are served by tramway for all loads to 1,200 lbs. This is a very desirable feature for rapidly handling medium-weight pieces. Heavy pieces, of course, require a traveling crane.

Gear- and rack-cutting and milling forms another department. In this will be noted among others: Brown & Sharpe, Fellows, and Gould and Eberhardt gear cutters and Garvin millers. The Fellows gear shaper attracts a good deal of attention from visitors on account of its novel mechanism. A gear testing machine and cutter grinding machine are necessary tools in this department. The gear testing device is shown in Fig. A and needs no explanation. The erecting floor is well lighted from the roof and side and is provided with overhead traveling cranes and tramways so that work may be expeditiously handled.

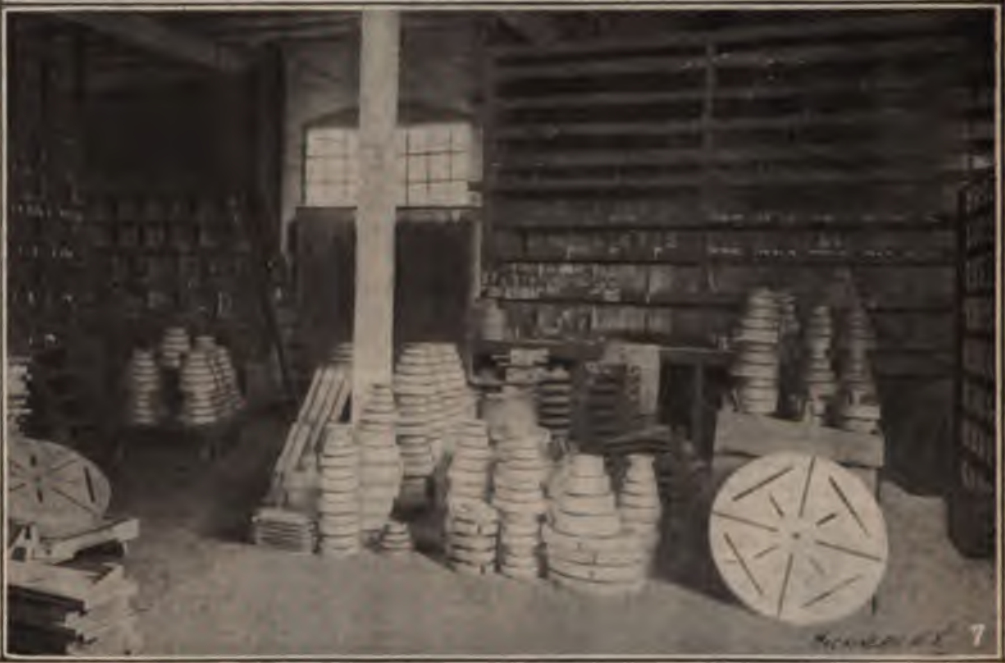
A full line of drill presses, from sensitive to radial, is arranged contiguous to the line shaft and takes care of the drilling.

The pattern and drafting rooms occupy the second floor. The drafting room is well lighted with a northern exposure and fitted out with removable board tables and parallel ruling devices. Auxiliary tables fitted with drawers for the reception of data sheets, memoranda, instruments, etc., add to the convenience of the room. A large cabinet, properly labeled, tells at a glance where to find the proof folio for a given machine.

2

3

6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Figs. 5 and 6. Erecting Floor, illustrating the general method of assembling lathes and drills. This floor is well lighted from both the sides and roof. A number of electric call buttons connected with an annunciator in the tool room, and the ubiquitous small boys commonly known as "tool-monkeys," maintain the tool service of the department.

Fig. 7. Casting Warehouse. Subdivided on the same plan as stock room; central steel rack extending from floor to ceiling; railway switch sunk to bring car floor level with warehouse floor, so as to facilitate the rapid unloading of cars; sliding doors are spaced so as to accommodate three cars at one time, the doors sliding behind casting compartments.

### OL COMPANY'S WORKS.

The stock room for finished parts acts as a sort of clearing house between the machine and erecting departments, and is an invaluable receiving, checking and distributing center for the one-hundred-and-one small parts that enter into a lot of tools. Our method of following up a given piece of work may be illustrated by taking some piece and tracing it from the casting shed to the shipping platform. We will take a spur gear, say for fifty machines. The foreman goes to the casting shed and notes that there are 55 pcs. L14, and gives the man in charge an order like that in Fig. B.

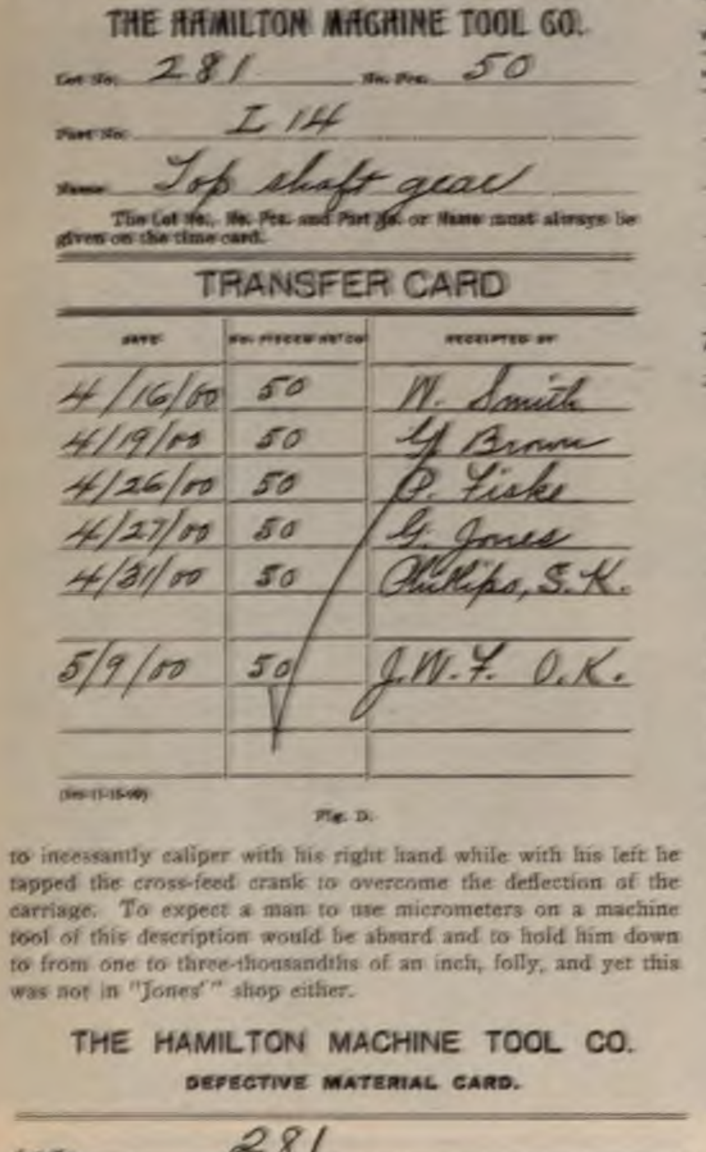
He takes them from the bin, weighs them, and charges their weight, say 281, against the lot. They are then delivered to the chucking lathe and the operator receives a piece work card (Fig. C) for his operation and a transfer card (D) is placed with the castings and is receipted for by the operator, Smith. After boring, facing and reaming they are passed on to the engine lathe, where Brown receipts to Smith for 50 pieces and finishes them up complete, except polishing. They are then polished by Fiske and sent to the gear room. After Hall has cut the teeth they are taken to the stock room, inspected and accepted and then are held subject to the final order of the erecting foreman, which cancels the card and accounts for every piece worked upon.

Of course, there are always a certain number of defective castings or pieces with poor workmanship, and this is traced and taken care of upon the accompanying blank form (Fig. E), which, after scrutiny by the superintendent, is forwarded to the stockkeeper to replace the parts thrown out. It will be understood that this system applies principally to small parts, and is very little trouble after it is once installed.

The daily time cards (Fig. F) are collected from boxes placed conveniently about the shop, before eight each morning, and are countersigned by the foreman of each department. They are then entered upon a weekly slip and finally upon the cost book.

The total number of hours per day is corrected to conform to the tape from the clock register.

The methods of manufacture are pretty much the same in all first-class shops and are controlled largely by the means placed in the hands of the superintendent or foreman. Figuratively speaking, no man can make "bricks without straw" now, any more than he could in the time of Moses; therefore, it is fairly axiomatic that given good tools and good men, good work will be the result. The writer remembers that back in the seventies, when running a flat-shear gap lathe, he was requested to turn a piece of shafting, and it was necessary when approaching the gap to incessantly caliper with his right hand while with his left he tapped the cross-feed crank to overcome the deflection of the carriage. To expect a man to use micrometers on a machine tool of this description would be absurd and to hold him down to from one to three-thousandths of an inch, folly, and yet this was not in "Jones'" shop either.



THE HAMILTON MACHINE TOOL CO.

Lot No. 281 No. Pcs. 50

Part No. I 14

Name Top shaft gear

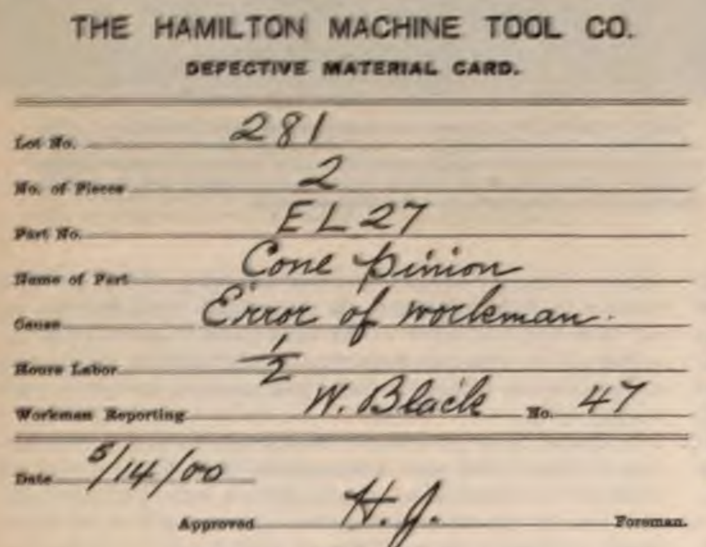
The Lot No., No. Pcs. and Part No. or Name must always be given on the time card.

TRANSFER CARD

| DATE | NO. PIECES REC'D | RECEIPTED BY |
|---|---|---|
| 4/16/00 | 50 | W. Smith |
| 4/19/00 | 50 | G. Brown |
| 4/26/00 | 50 | O. Fiske |
| 4/27/00 | 50 | G. Jones |
| 4/31/00 | 50 | Phillips, S. K. |
| 5/9/00 | 50 | J.W.F. O.K. |
| | | |

(500-11-15-99)

Fig. D.



THE HAMILTON MACHINE TOOL CO.

DEFECTIVE MATERIAL CARD.

Lot No. 281

No. of Pieces 2

Part No. EL27

Name of Part Cone pinion

Cause Error of workman.

Hours Labor ½

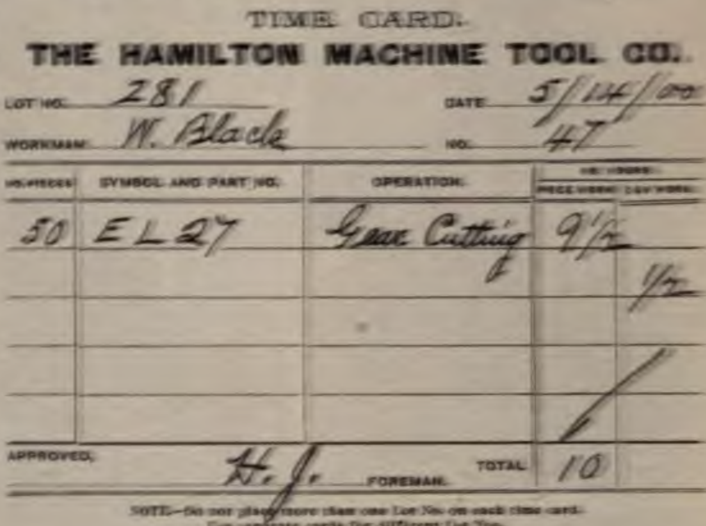
Workman Reporting W. Black No. 47

Date 5/14/00

Approved H. J. Foreman.

Fig. E.

We endeavor to give our men good tools and then we feel we have a right to expect good work and plenty of it, and it gives me pleasure to say that our men generally "rise to the occasion." It therefore follows that all spindles are ground to standards, that the phosphor bronze journals are carefully fitted to the headstocks of our lathes and that great care is taken to insure perfect alignment. Our method of proving is to insert a hollow steel bar in the spindle. The bar has two collars upon it, accurately ground to the same diameter, one located close to the spindle nose, and the other at the end of the bar. After this bar is inserted in the spindle, an indicator is placed in the tool-post and arranged to reach both the sides and top of the bar. By moving the carriage along, the deflection in thousandths either way may be noted and corrected. To insure that the journal is round, or that the taper hole is central, the spindle is rotated and the fluctuations of the needle noted. In this case it must be remembered that the actual error is just one-half that indicated. I may say these bars are from 18" to 30" long.



TIME CARD.

THE HAMILTON MACHINE TOOL CO.

LOT NO. 281 DATE 5/14/00

WORKMAN W. Black NO. 47

| NO. PIECES | SYMBOL AND PART NO. | OPERATION | NO. HOURS PIECE WORK | NO. HOURS DAY WORK |
|---|---|---|---|---|
| 50 | EL 27 | Gear Cutting | 9½ | |
| | | | | ½ |
| | | | | |
| | | | | |
| | | | | |
| APPROVED, H. J. FOREMAN. | | TOTAL | 10 | |

NOTE.—Do not place more than one Lot No. on each time card. Use separate cards for different Lot Nos.

Fig. F.

Other bars with cast-iron collars pressed upon them are inserted in the spindle and a cut taken over them, the micrometers applied and variation noted. But, not to be tedious over well known methods, I would say with Bobbie Burns, "The best laid plans of mice and men gang aft aglee," and that only in ceaseless vigilance is perfection found.

THE HAMILTON MACHINE TOOL CO.

Name of Workman, *John W. Smith.*

Time for Week Ending *May 25, 1900.* 23 1-2

Kind of Work, *Lathe Work.* Workman's No. *70.*

| Lot No. | Sat. | Mon. | Tues. | Wed. | Thu. | Fri. | Total Hours | Amount | |
|---|---|---|---|---|---|---|---|---|---|
| 275 | 3 | 4¼ | | | | ½ | 7¾ | 1 | 82 |
| 264 | | ½ | | 4 | | ½ | 5 | 1 | 18 |
| Special | | ½ | 2¼ | | | | 2¾ | | 64 |
| 283 | 2¼ | 5¼ | | | | 4 | 11½ | 2 | 71 |
| 272 | | | 4¼ | | | 1¼ | 5½ | 1 | 29 |
| Stock | | | 3½ | 1½ | 9½ | | 14½ | 3 | 42 |
| Gen. expense | | | | ¾ | | | ¾ | | 17 |
| 266 | 2½ | | | 4¼ | | | 6¾ | 1 | 58 |
| 285 | | | | | ¾ | | ¾ | | 18 |
| 287 | | | | | | 3 | 3 | | 71 |
| 284 | 1 | | | | | ¾ | 1¾ | | 40 |
| | | | | | | | | | |
| Total | | | | | | | 60 | 14 | 10 |

Fig. G.

Carefully designed jigs and templates fitted with ground steel bushes assist in the rapid duplication of parts, and standard plugs and limit gages hold internal diameters where they belong. Drive, tight, loose and running fits should always be made on the shaft or stud.

But I am afraid my patient readers may think these "Snap Shots," unduly "exposed," so close by extending a cordial invitation to visit our works.

* * *

Leslie's Weekly makes a statement which forcibly shows the effect of labor-saving machinery when it says that the Chinese are a nation living in brick houses in a land without a brick-making machine. All the millions of homes in the thousands of walled cities are built of brick, and every brick made by hand. These bricks are made by labor costing but ten cents per day, still they cost more than our machine brick made with labor costing twenty-five times as much.

# ACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION,—9.

## LATHE ATTACHMENTS.

W. H. VAN DERVOORT.

e use of special attachments on the lathe frequently makes ble the machining of work that could not otherwise be ac- lished on this tool. This was in a measure illustrated in nethod shown in article 8 for the turning of spheres and . The following examples will serve to show a few attach- s which will often be of great value, especially in shops ng limited equipment, and where the lathe must often do work of milling machine, boring mill or shaper.

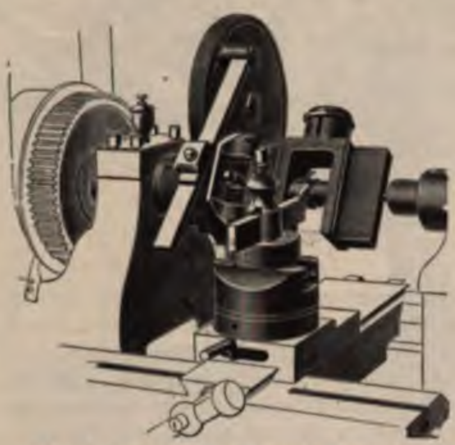
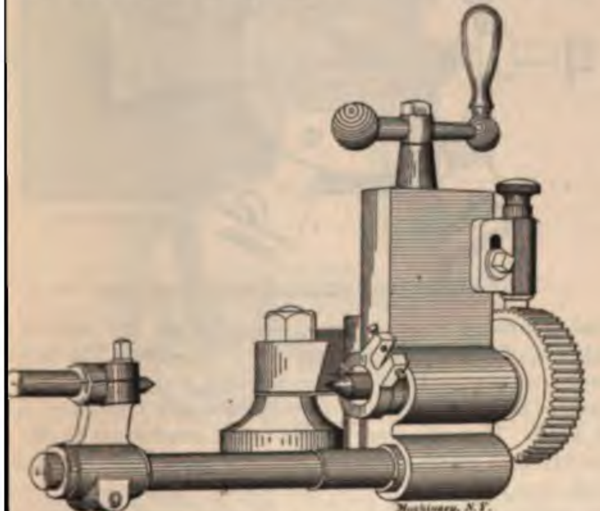


Fig. 76. Cross-head Pin Turning Attachment.

Fig. 76 is a patented device used on the lathe for the ng of cross-head pins or other surfaces the nature of which ents the possibility of complete rotation of the work. In device a sleeve carrying two gears is secured on the nose ne lathe spindle. The gear next to the spindle bearing is d to the sleeve and rotates with the spindle. The second which carries the work driver rotates freely upon the sleeve. first gear meshes with a larger one that is carried on a ket secured to the back of the head stock. A wrist pin in ace of the large gear drives the rack which, as shown, gears and drives the loose gear and thus causes the work to rotate pendent of the spindle rotation. By properly proportioning diameter of the gears and the stroke of the rack, the work be made to oscillate back and forward through any desired of the revolution, while the spindle has continuous forward ion. Thus in the turning of the cross-head pin shown, the



Machinery, N.Y.

Fig. 77. Lathe Milling Attachment.

-head moves through rather more than one-half of the full ution, thus enabling the turning of a little more than one- of the pin. The cross-head is then changed end for end e centers and the other half turned. Frequently, with cross- to be used in single acting engines, where the pressure and are always on one side of the pin, a large flat can be machined on the non-bearing side of the pin and sufficient rotation obtained to completely finish the pin without changing ends with the work. It is, of course, possible to turn a pin of this character without any special attachment, by either pulling the belt backward and forward and driving the work in the ordinary manner or by allowing it to rotate free on the centers and oscillating it by means of a wrench or lever. These latter methods are slow and require an extra workman.

Fig. 77 serves to illustrate a class of attachments that can be advantageously used for performing milling operations on the lathe. The attachment shown is secured to the tool block in the place of the tool post. The construction is such as to provide for suitable vertical adjustment, and the milling cutter to be used is carried on an arbor held between the lathe centers. The attachment shown is suitable only for light milling operations, as it is not sufficiently rigid for heavy work. An attachment constructed along the same lines and attached to the carriage in place of the cross-slide can be made sufficiently rigid to enable heavy work to be done upon it and will, in the absence of a milling machine, be found a most useful device. If it is required to bore a hole in a piece of work parallel to another hole that has been bored in the lathe, it is necessary to offset the work until the required bore is concentric with the axis of rotation. This involves very accurate chucking, and if the work is large, the swing of the lathe will frequently not permit sufficient offset. When enough work of this character is to be done to warrant its construction the attachment shown in Fig. 78 will be found very satisfactory. Its construction is simple, consisting of a suitable bearing that can be secured to the tool block and carrying a spindle or boring bar. A pulley for driving the bar can be attached directly to its outer end, or if the amount of use the attachment is to be put to will warrant it, it can be constructed as shown in the figure. The spindle in this case is provided with a taper bearing at F to receive a taper shank drill, an end milling cutter or a short boring bar. The outer end of the spindle carries the gear B; gear C meshes with B and is carried on a radially adjustable stud. Gears B and C should be made to interchange or even be replaced by others, and thus provide for changes of speed on the spindle. The driving pulley E is carried loose on a suitable stud D, which clamps over the nose of the tail spindle. A pair of universal couplings with a telescoping shaft connects E and C and transmits the power. In the operation of this attachment belted power is transmitted to E and to the regular lathe feeds used for advancing the cutter to the work. The face plate must be blocked to prevent the work from turning. In Fig. 79 is shown a satisfactory method of blocking the face plate and, at the same time, of providing an adjustment for accurately locating the position of the bore. An attachment of this kind will frequently be found quite valuable

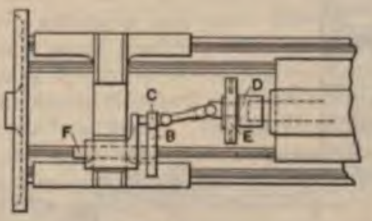
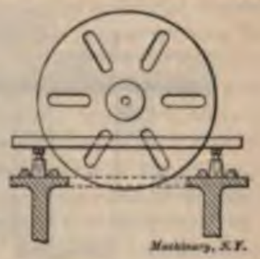


Fig. 78.



Machinery, N.Y.

Fig. 79.

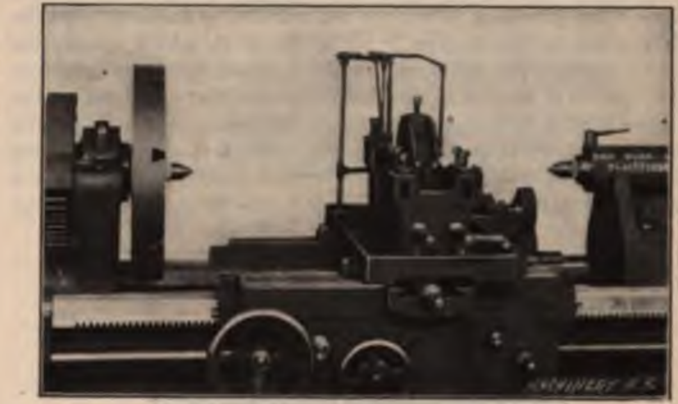


Fig. 80. Shafting Turning Attachment.

as, for example, in the boring of a crank disc for shaft and crank pin, the attachment boring the hole for the pin with reasonable certainty of getting it parallel with the bore for the crank shaft.

In Fig. 80 is shown an attachment secured to the carriage of an engine lathe for turning shafting. With this device the shaft is roughed down by two tools set opposite to each other, which serves to balance the pressure of the cut and reduce the spring to a minimum. After the roughing cuts, it passes through a suitable bushing held in the head and receives the final sizing and finishing cut from the tool shown at the back of the attachment. The device is simply a follow rest carrying three tools instead of one.

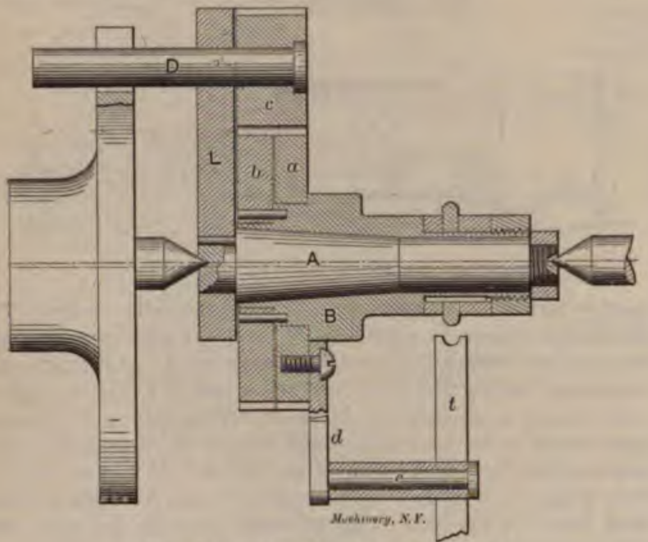


Fig. 81. Device for Backing-off Cutters.

An ingenious patented lathe attachment for backing off of the teeth of milling cutters is shown in Fig. 81. In a device of this character either the tool or the work must be given a slight in-and-out motion for each tooth on the cutter being relieved. In the case shown, the tool is held in the tool post and advanced to its cut in the ordinary manner. The mandrel A of the attachment has its centers slightly eccentric, the amount of the eccentricity being enough to produce the desired amount of relief on one tooth of the cutter if mounted directly on the mandrel. The arm L is secured to the mandrel and driven from the face plate by the carrier D. The sleeve B, which carries the cutter being operated upon, revolves freely upon the mandrel. The gear b is secured to the sleeve and the gear a is loose on the sleeve, and is held from rotating by the arm d which is secured to it and rests upon the top of the tool; c is a pinion carried loose on the stud D and gears with a and b. Gear b has a smaller number of teeth than a, and as a does not rotate, the rotation of the pinion c around a advances b and the sleeve and cutter a certain fixed amount at each revolution of the mandrel. The geared ratio is such for any given number of teeth in the cutter that the advance per revolution is exactly equal to the circular pitch of the teeth in the cutter. The turning is such as to bring a tooth to the tool when the center of the mandrel is farthest from the tool, thus giving the relief as the tooth advances to the tool. It is evident from the above that the space between the teeth must be at least equal to the length of the tooth. As this division of space and tooth in relieved milling cutters is not usual, it is necessary to allow the cutter blank to stand still while the mandrel is moving through a part of its revolution. This is accomplished by making the circular pitch of the teeth on about one-half the circumference of b equal to that of the teeth on a and the teeth on the balance of b of somewhat greater circular pitch. For that portion where the teeth are the same on a and b, the pinion simply turns around both and the sleeve remains stationary. During the balance of the revolution, however, the sleeve will advance an amount equal to the circular pitch of the cutter's tooth.

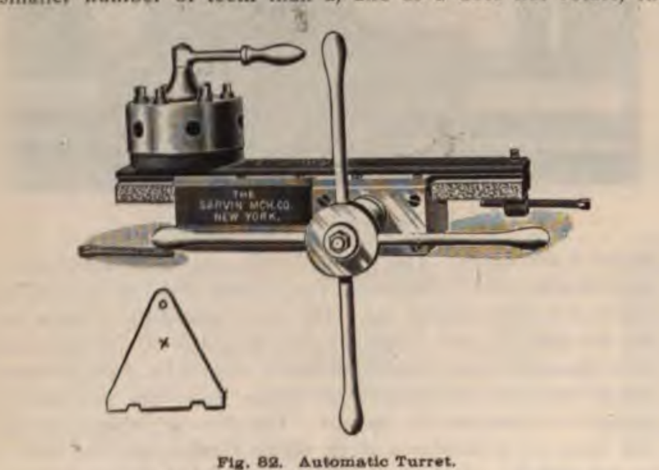


Fig. 82. Automatic Turret.

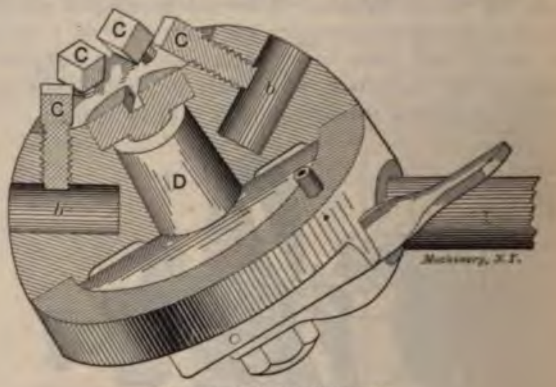


Fig. 83. Tail-stock Turret.

In Fig. 82 is shown what is known as a turret attachment, which may be applied to the ordinary engine lathe in place of the tail stock, or on the carriage in place of the tool block, a somewhat different design being required for each application. A third and still simpler application is shown in Fig. 83, where a small turret head is applied to the tail spindle of the lathe. In construction the turret is simply a revolving head provided with a number of holes in which the tools to be operated are secured by set screws. These holes are axially true with the line of the centers, and the turret can be rotated so as to bring each of the holes successively into the line of centers, a suitable lock and clamp holding it in each position. In the simpler forms, the turret is rotated and locked by hand while in the class known as the automatic and illustrated in Fig. 82, the turret slide is operated by the turnstile, the mechanism being such that the head is rotated through one division by the last portion of the slide's stroke in carrying it back from the work. The turret slide for the smaller sizes is usually operated with a lever, and, when used for facing operations, is provided with a cross feed operated by hand. The advantage of the turret attachment is due to the rapidity with which different tools can be brought into action on work requiring a variety of operations. Turret head operations are confined almost entirely to chucked work and can be economically employed only when a number of similar pieces are to be machined. From the plan view of the turret head shown in Fig. 84, the several operations in an important application—that of making a machine screw—are clearly shown. The end gage determines the length of stock to extend from the chuck. The turner reduces the stock to nearly the exact size. The sizer takes the finishing or sizing cut and the die runs the thread, all of the operations being performed with much less loss of time

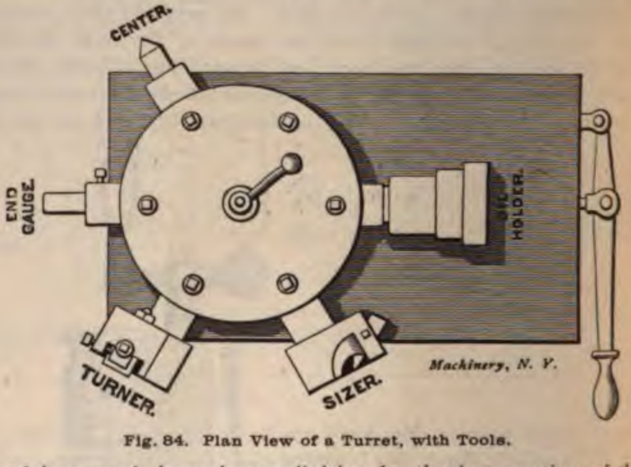


Fig. 84. Plan View of a Turret, with Tools.

ing from one tool to another than would be the case if
work were done in the common engine lathe.
arge percentage of lathe work is held in the chuck and
only short tool travel, classes of lathes for this character
with short beds fitted with turret heads and known as
and chucking lathes, and screw machines, are made.
illustrates a monitor lathe. The turret slide is operated
ever or screw and provided with a cross adjustment for
A suitable stop on the cross shear enables the turret to
y brought back to a central position. These lathes may

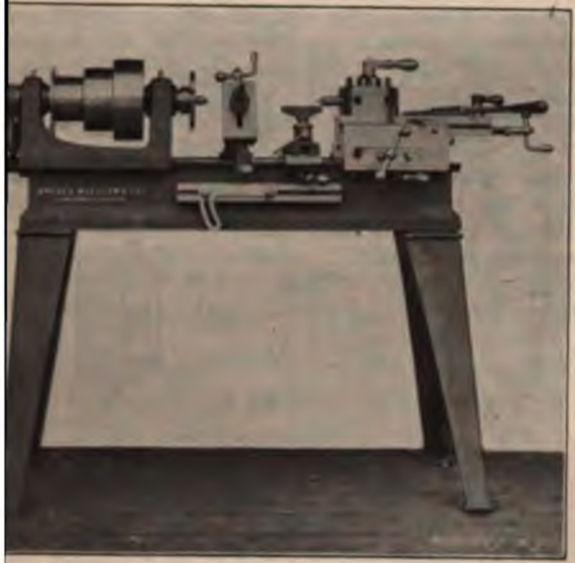


Fig. 85. Monitor Lathe.

either with or without back gears. The inclined chaser
ich carries an inverted tool used for forming, boring and
g, is carried on a rigid chaser bar mounted on the rear
ed. The bar slides endwise and also rotates in its bear-
us allowing the head to be turned back out of the way
t in use. For threading purposes, the end of the chaser
ies what is known as the "follower," which engages the
"leader" shown at the left of the head stock. The
ay be of any desired pitch and need not be long, as the
r of the threads cut does not require it. As many of the

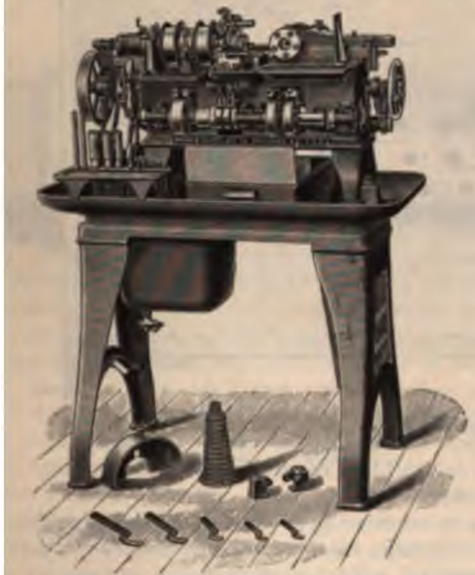


Fig. 86. Automatic Screw Machine.

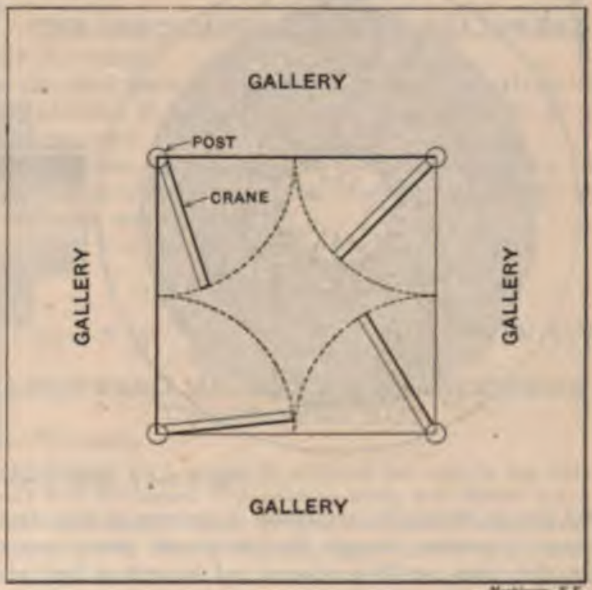
cut in a lathe of this class are pipe threads, some pro-
ust be made for cutting them on a taper. In the ma-
own, the lever rest on the front of the lathe will, when
angle with the top of the shears, throw the lever and
as it advances over the cut, thus producing a tapered
By raising the lever at the end of the cut, the follower is
ed and the tool can be quickly returned for another cut.
justed to its cut in the ordinary manner. These lathes
lly furnished with a simple tool rest for hand turning.
er head can be used for cutting-off purposes. A cut-off tool can be held inverted in rear tool post and a chamfering or rounding tool held in the other. A forward motion to the lever brings the cuttting-off tool into action. After the work is cut off the chamfering tool is brought into action by an outward motion of the lever. The monitor lathe is strictly a brass finisher's lathe and very largely used upon all classes of valves and fittings.

The screw machine in its simple form differs but little from the monitor lathe here described, as it cuts its threads with a die. The chasing head and bar are omitted, and, as its work is all done over the end of the stock, a cross adjustment to the turret is not necessary. The hollow spindle is fitted with a draw-up chuck at its nose and steady chuck at the rear for holding the stock, these chucks being quickly operated by means of a lever. The wire feed for advancing the stock the proper amount for each setting is now quite generally employed. The full automatic screw machine, while embodying the same general principles, has in the developing of its automatic features become so completely disguised as to almost lose its identity as a member of the lathe family. In Fig. 86 is shown a view of the full automatic screw machine. With machines of this class it is simply necessary to keep them supplied with stock, one man watching a number of machines without difficulty. It should be understood that the screw machine while designed for the manufacture of machine screws is capable of doing a very wide range of other work.

[Of the illustrations in this article, that of the cross-head pin turning device was kindly furnished by B. J. Coates, Erie, Pa.; of the automatic turret, by the Garvin Machine Co., New York; of the automatic screw machine by the Brown and Sharpe Mfg. Co., Providence, R. I.; and the illustrations of the shaft-turning device and of the monitor lathe are from photographs furnished by the Pond Machine Tool Co., Plainfield, N. J. and Dreses, Mueller & Co., Cincinnati, O., respectively.—Editor.]

* * *

The machine shop building of Houston, Stanwood & Gamble, Cincinnati, builders of steam engines, cannot be classed as modern, for it was put up many years ago. It is, however, an interesting structure from the fact that, although dating from before the time of traveling cranes, it contains a number of modern features that make it well adapted to the work that is done within its walls, even at this advanced time when new and modern shops are generally considered so essential. The accompanying diagram is a rough sketch of the floor plan. The building is square, or nearly so, and has a gallery around the four sides for small machine tools, fitting, etc. The main floor is served by four jib cranes turning on posts at the inner corners of the galleries. These can reach nearly all parts of the erecting floor, which is the central part of the shop, not covered by the galleries, and open to the roof. The large tools are placed either wholly or partly under the galleries and are easily served by the cranes. The shop is lighted by side windows in the walls and also by windows in the roof, which is of the monitor type. The ideas embodied in this shop building may prove suggestive, even to builders of new shops.



Floor Plan.

# LETTERS UPON PRACTICAL SUBJECTS.

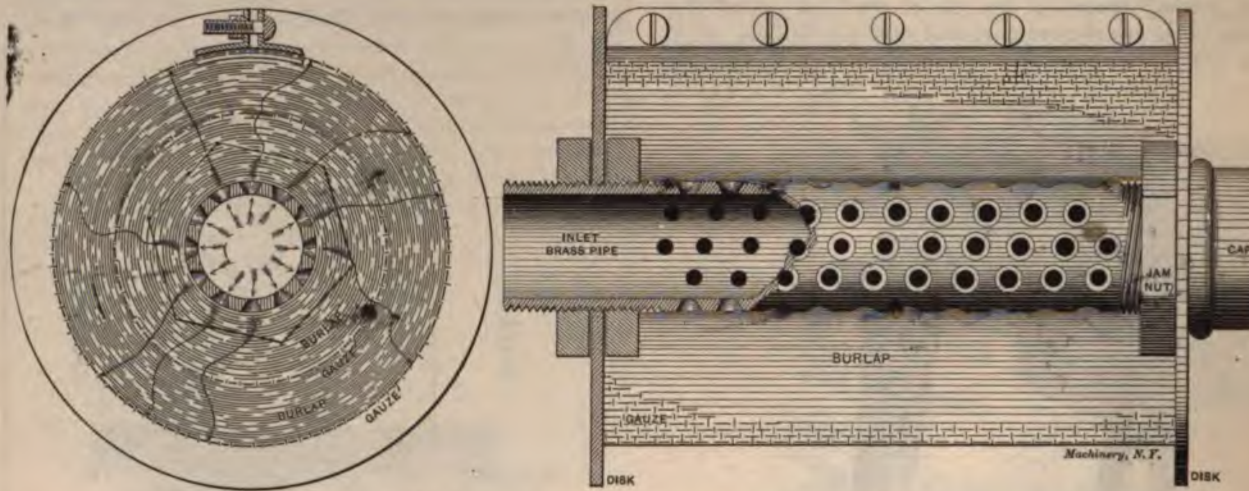
## A SILENT CONDENSER OF STEAM UNDER WATER.

*Editor* MACHINERY:

One of the most annoying sounds that frail humanity has to endure is the noise made from "water-hammer," created by steam being blown into a fluid to heat it, or to condense the vapor from wastes. The vibration from this hammering not only wrecks the nervous system of those who are compelled to be in its neighborhood, but it starts almost every joint to leaking in the system of pipes to which it is connected, which causes many delays and unnecessary expense in making repairs. As this often occurs in the many processes of manufacture, there are many sufferers from this cause. To obviate this trouble, I herewith submit an arrangement, which I hope will be of interest to the readers of this journal and of some practical service to those who are suffering from this nuisance.

The simplicity of construction of this device places it within reach of any ordinary mechanic, as it can be made at a very reasonable cost. It consists of a piece of brass pipe with countersunk perforations and a thread at each end to receive the locknuts and cap. One end is threaded longer than the other to receive the fitting, in making connections, as shown in Fig. 2. This arrangement is in the form of a spool, upon which is tightly wound alternate strips of burlap and fine-meshed brass wire gauze. The strips should be the width of the distance between the discs and the object of placing gauze with the burlap is to prevent it from being blown away by the steam. The outer casing of gauze is secured by means of angle pieces soldered or riveted to the edges and drawn together by means of bolts. Under this joint is placed a flat strip of metal so that the edges can ride without tearing the burlap. The brass pipe should be sufficiently long between the discs to receive enough perforations to equal twice the area of the steam pipe. The smaller the holes, the better the results obtained. The burlap and gauze are wound around the spool to a thickness of one and a half to two inches.

The steam in passing through this object, is exposed to an increased area of surface in comparison to the area of pipe, and its divisions, in passing through the burlap and gauze, are very minute; the steam rapidly condenses and imparts its heat to the surrounding fluid, and whatever of "water-hammer" occurs, cushions on the soft burlap, thus making a noiseless device for this service.



Figs. 1 and 2. Silent Condenser for Steam Escaping Under Water.

There are manifold purposes to which this nozzle can be applied, such as heating feed water in precipitating tanks, bathing pools, process kettles, or for any purpose where hot water is required and the absence of noise is a factor. It is an excellent terminal for bleeders and drains from steam traps which are led to tanks to save feed water and vapor from arising.

This noiseless condenser of vapor under a fluid will do all that is here claimed for it, and its application I leave to the ingenuity of the modern mechanic. GEO. C. STANLEY.

Norfolk Navy Yard.

## DEVICE FOR CENTERING CRANK SHAFTS.

*Editor* MACHINERY:

I send herewith a sketch of a fixture to be used for centering crank shafts.

Fig. 1 shows the shaft in its finished state. Stock large enough to make the shaft is taken, centered, faced and turned on each end to fit the fixture as shown in Fig. 2.

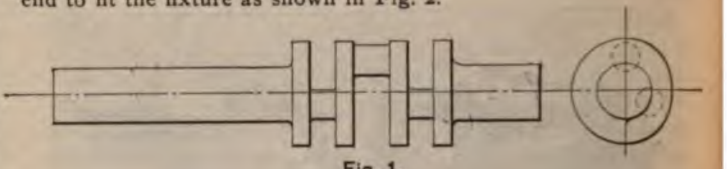


Fig. 1.

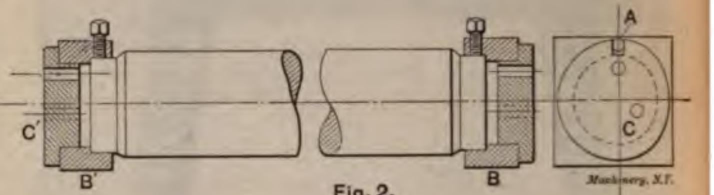


Fig. 2.

Centering Crank Shaft.

The shoulder in the main piece B of the fixture limits the distance to which the shaft enters. Fixtures are planed on the bottom and after being set on the platen, the shaft is put into the holes of the fixtures and then held by set screws for the centering operation.

The holes in the steel piece C, which fits in the other end of the fixture, are made to fit a combination center drill and countersink, so that both results are accomplished in one operation.

The piece is made removable so that other pieces may be fitted for different work. These are brought into line by means of the pin A shown in the end view. A. A. B.

Hartford, Conn.

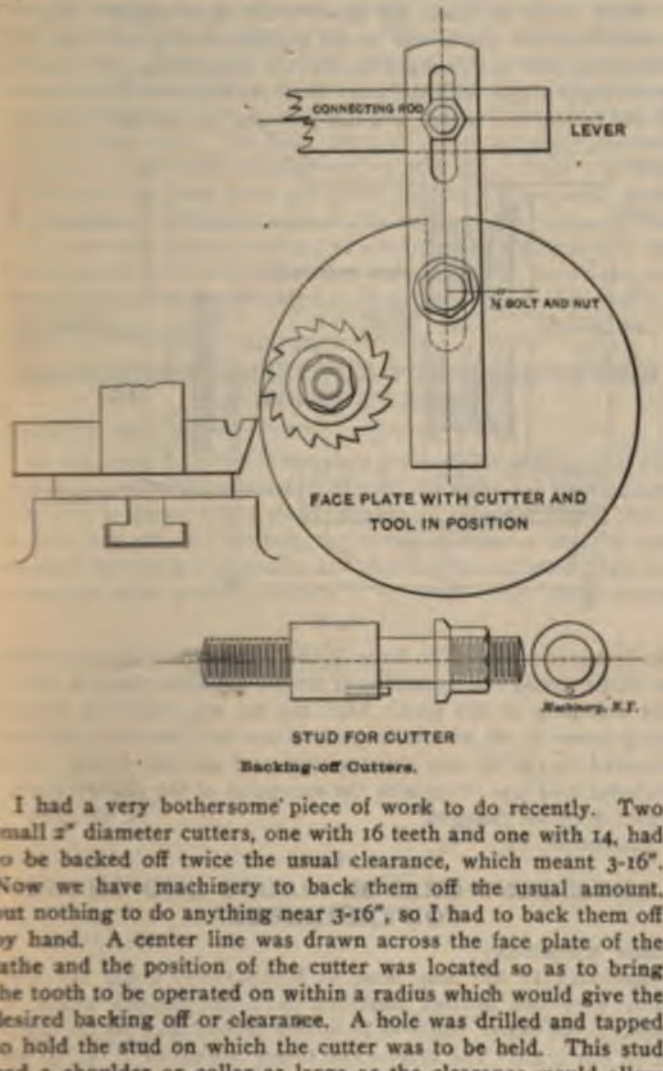
## "HOW AND WHY."

*Editor* MACHINERY:

In answer to question 54 in May issue of MACHINERY, would say that the following receipt can be used to brown gun barrels: Spirits of wine, 1½ ounce; tincture of iron, 1½ ounce; corrosive sublimate, 1½ ounce, sweet spirits nitre, 1½ ounce, blue vitriol, 1 ounce, nitric acid, ¾ ounce. Mix and dissolve in one quart warm water and keep in a glass jar. Clean the barrel with a hot solution of caustic soda to remove all grease, etc., and polish bright with emery cloth. Stop the mouth of the barrel and also the vent with wooden plugs and be sure all finger marks are removed from the surface of the barrel. Apply the mixture with a sponge or rag and expose to the air for 24 hours; then rub the loose rust off with a steel scratch-brush and apply the mixture once or twice more if necessary. Wash in boiling water and rub down with boiled linseed oil.

To blue gun barrels, clean the barrel as stated before, dissolve 4½ ounces hyposulphite of soda in 1 quart of water, also dissolve 1¼ ounces of acetate of lead in 1 quart of water. Mix these two solutions together in a porcelain-lined vessel and boil. Warm the barrel and apply the mixture with a sponge or rag tied on a stick. When color develops, wash, wipe dry and finish with linseed oil. The barrel may be blued by heat but it takes considerable experience to do this. There are several other formulas for the above but I do not wish to take up time and valuable space. If desired, they can be obtained by a personal letter.

To cement leather to iron, the iron surface must be free from oil or grease, as also the leather. Steep ½ dozen of bruised nut galls in one quart of clean soft water, for about six hours. Take best glue and let it soak 24 hours in its equal weight of water; then heat and dissolve. Strain the nut gall solution and apply to the leather, which must be warm also. Have the pulley warm and apply the glue to the pulley and put them both together. The surface of the pulley should be slightly rough just as the tool leaves it and not filed. In cases where the surface is smooth and polished, rub it with a raw onion cut in halves, cover the surface thoroughly and let it dry. The glue adheres very firmly but in every instance all surfaces must be free from grease or dirt.



Backing-off Cutters.

I had a very bothersome piece of work to do recently. Two small 2" diameter cutters, one with 16 teeth and one with 14, had to be backed off twice the usual clearance, which meant 3-16". Now we have machinery to back them off the usual amount, but nothing to do anything near 3-16", so I had to back them off by hand. A center line was drawn across the face plate of the lathe and the position of the cutter was located so as to bring the tooth to be operated on within a radius which would give the desired backing off or clearance. A hole was drilled and tapped to hold the stud on which the cutter was to be held. This stud had a shoulder or collar as large as the clearance would allow and 1½" long, so as not to have the face plate or work conflict with any part of the carriage, etc. The shoulder also had a pin placed so that the cutter would always be in proper position when shifted from tooth to tooth. The stud was screwed into the face plate and the check nut brought up tight, for everything must be rigid in this operation. The cutter was put on and another collar or washer as large as feasible, and then the nut was screwed up tight.

The usual way of operating with this rig is to have a lever bolted on to the face plate and a stop so as to allow the cutter to travel just so far back and forth, but this is a rather tedious operation. This objection can be overcome if another lathe is near and parallel with the one in which the operation is to be performed. Slot the lever and put a crank-shaft in the other lathe. Connect both with a rather stiff connecting-rod and have the crank of the proper throw; when the lathe is started up it leaves the operator with two hands to manipulate the feed, etc. The crank-shaft can easily be made from any old piece of scrap, the right length being determined by the position of the lathes. One end is held in the chuck and the other in the steady rest. A pin driven in the end, when the proper throw is determined, forms a very good and cheap crank.

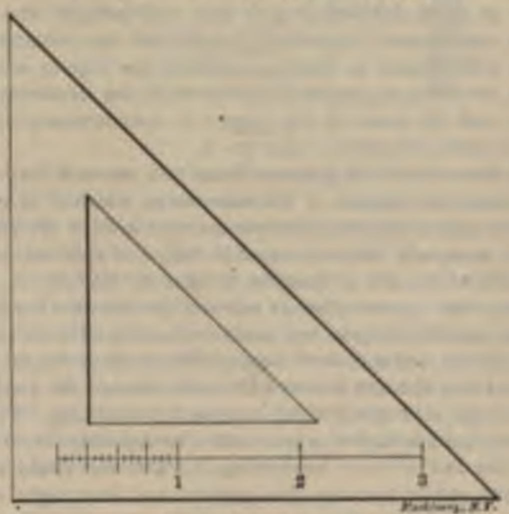
Dorchester, Mass. S. Wrench.

* * *

## DRAFTSMAN'S TRIANGLE WITH SCALE.

*Editor* Machinery:

If a draftsman will mark off a scale similar to that in the sketch on a celluloid triangle he will find it a great convenience in setting his compasses and dividers. If he will also paste a few pieces of card board about ¼ inch wide, 1-16 inch thick and 2 inches long and at intervals of about 16 inches on the bottom side of his T square blade, he will find that his drawing will not get as badly soiled as when the blade lays perfectly flat on the paper.



Graduated Triangle.

Greensburg, Pa. C. C. R.

* * *

## THE CIRCUMFERENCE OF ELLIPSES.

*Editor* Machinery:

In the April issue on page 248 in the article by Henry Hess, "Circumference of Ellipses," he gives three formulas for computing the same.

The following formula has been used for some years, and is a nearer approximation than that of Nystrom or Molesworth, besides being much simpler.

Let a and b = the semi-diameters, then

$$\text{cir} = \pi\left(\frac{3(a+b)}{2} - \sqrt{a\,b}\right)$$

Brooklyn, N. Y. H. W. N. Cole.

* * *

## PLANER FEED MECHANISM—FASTENINGS OF CROSS-FEED NUT.

*Editor* Machinery:

It appears to be a generally accepted fact among machine designers and draftsmen that friction feeds and drives are a desirable and essential feature to most any class of machinery. In this respect they should be encouraged, for the fact cannot be overlooked that the usefulness and effectiveness of this feeding device are daily increasing and will continue to do so for some time. It would seem, however, that friction feeds like all "good things" are pushed a little too far, not alone by the designer, but by the machine that pushes them along. It has always appeared ridiculous to me to see a 12' or 16' planer on full cut, dragging a friction disc feed 24' or 32', as the case may be, in order to move the feed gear two or three teeth. It is a clear case of "the tail wagging the dog" with a vengeance. That this style of feed gives entire satisfaction cannot be denied, and I suppose for this reason it is allowed to remain in its present form. But that this style of feed requires considerable power to overcome the friction when the planer is in motion, can be found by any one who will take the trouble to turn the tight pulley by hand with the feed disc turning freely between striking poppets and then after the disc has struck the poppets. I have been frequently misled as to the cause of the sudden sticking, as it were, and invariably looked to see if the dogs were up against the tripper arm. No doubt, some of the readers will say that it was a clear case of a man with a monkey wrench and the adjustment within his reach, but it was not, for loosening up the binding bolts did not remedy the evil. It allowed the pulley to turn easier, but stopped the feed. This has been the writer's experience in numerous instances with different styles of friction feeds. It seems to me that if the designers took into consideration the amount of power necessary to sustain this device on a planer, they would certainly change it, or alter it in such a way that when the disc struck the poppets the friction would be released, as the feed only occurs between poppets. While I do not believe in retrogression, I think that the tripper arm feed should be given some consideration. I do not mean to employ the rod and fan gear feed, but an up-to-date affair with rack and variable feed. This would be the cheapest method for feeding, as the momentum of the table alone would be sufficient to send the tripper arm over. It would, however, be necessary to increase the thickness of the dog, slot and all parts of the tripper to commensurate for the increased work brought to bear on it.

The cross-feed nut on a planer head is a never failing source of annoyance on account of the manner in which it is secured. In the first place, the two little screws that hold it are sadly inadequate, especially when the tool is taking a side cut, and the whole force of the cut is brought to bear on the screws. I am well aware that in some planers recesses are cut into the back of the saddle for the nut to fit into and in others dowel pins are used. Still the screws and nut work loose. The remedy would appear to be in having the nut fastened from the rear of the saddle and using at least four good sized screws for fastening. To reach this a reinforced hole five or six inches in diameter could be put in the cross rail without weakening it. The nut could be fastened to the saddle through this opening and kept tight without having to take the head apart to reach the screws. T. B. C.

Brooklyn, N. Y.

* * *

## CUTTING A KEY FROM THE SOLID-GROOVING ATTACHMENT FOR LATHE.

*Editor* MACHINERY:

A little wrinkle which may be useful to some readers of this journal, was made use of to good advantage on the following described job:

A brass sleeve shown in Fig. 1 required the key to be worked out of the solid. The sleeve was finished all over and a groove 1/16" wide cut at A to a diameter of 2". The sleeve A was then placed on one of the T-slots of a shaper as shown in Fig. 2 and clamped so that it could be easily turned by hand, yet have no shake. The clamp plate was screwed down tight on the distance pieces B B which may be made of anything that will answer the purpose. Plates were bolted to the shaper table at each end of the sleeve to answer as stops. The time required for rigging up and doing the job was only one and one-half hours. It will be noticed that it would have been practically impossible to have set a feather in the sleeve on account of the thinness of the metal.

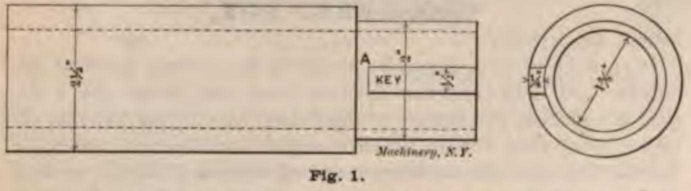


Fig. 1.

Another scheme, which may be of interest, is the method of chasing a groove of 1½" pitch on some cast-iron wheels. The groove started at zero depth and increased to 1½" in one revolution and then decreased to zero depth in the second revolution. The job was not required to be very accurate as the wheels were to be used for a wire rope, so we rigged up the arrangement shown in Fig. 3.

A wheel was chucked in the lathe and a 2¼" flat bar F put between the centers, passing through the hole in the drum which was somewhat larger in diameter. A 48-tooth change gear which had a 2¼" hole (hence the 2¼" bar) was keyed to the flat bar. The bar was driven by a dog engaged with a spoke of the wheel. A plate A was bolted to the lathe bed and to it was bolted the block B carrying the stud C. A 96-tooth change gear was keyed to a sleeve that turned freely on this stud, as was also a crank disc having a crank-pin of 2" throw. A connecting-rod from the crank-pin was attached to the lever D which was pivoted at E. The piece to which the lever was fulcrumed was bolted to the lathe carriage as shown. The lever was connected to the cross-feed screw by a fork and pin passing through an elongated hole to allow for the angularity of movement. The cross-feed screw was, of course, disconnected from the carriage so that it could be pushed in or out without interference.

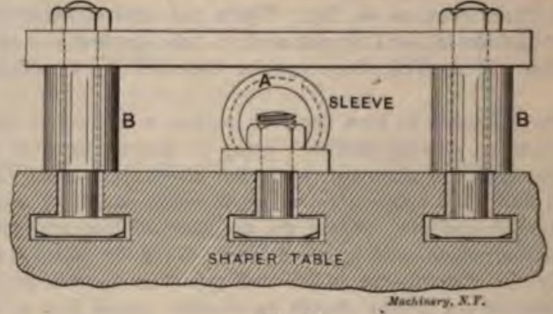


Fig. 2.

When ready to chase the groove, the lathe spindle was revolved until the crank was in the position shown and then the lead screw nut was engaged so that the connecting-rod stood at about right angles with the ways when the tool was in the center of the face of the wheel, and the tool was fed into the work by the compound rest. The holes in the connecting-rod were made so that it could vibrate sideways for the required distance without cramping on the pins. After the rig was ready we chased the grooves in the wheels in one and one-half hour and the time required to rig up was about twelve and one-half hours. The material used was scrap with the exception of the change gears, which were not changed. A. MERTES.

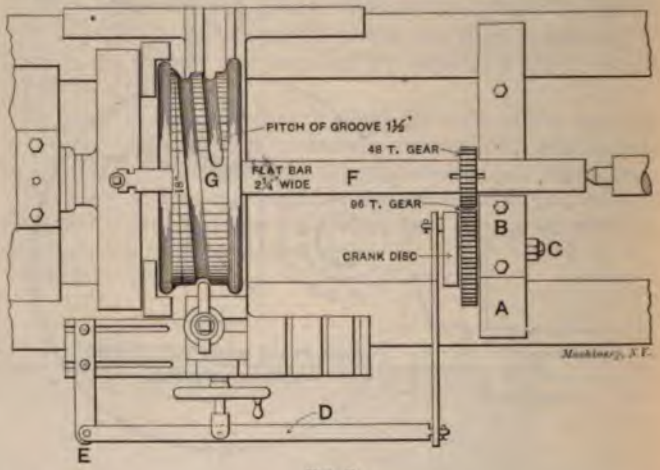


Fig. 3.

Emsworth, Pa.

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## REGARDING SHAPER SLIDES AND OILING CONVENIENCES.

*Editor* MACHINERY:

Referring to the May issue of MACHINERY, would say that there were two articles published in it on subjects which, it seems to the writer, ought to be further probed into, for the benefit of our craft. The first is the timely article by C. C. S. on "The Adjustment of Shaper Slides, etc." The fact is only too true that the temptation to handle the screw-driver on gib screws is too commonly resorted to among our fellow-craftsmen, when they ought, instead, to make haste to the grindstone and put their tools in proper shape and also see that all the slides and the ram are properly gibbed, clean and well lubricated.

All mechanics should know how to use these various tools, yet when such a construction is employed, how heedlessly the screw driver and oil-can are often handled. Still it is a simple thing to adjust a gib properly. An experienced erecting man gave the writer "a secret of the trade regarding gibs," which I will give here.

Slides, rams or cross-slides come under the same head. After ruide opposite the gib is "lined up," adjust the other guide b so that the slide ram or cross-head will move throughout ntire stroke with the same degree of smoothness without the f any lubricant, unless in very large work, where a judicious int of dry plumbago would be of service. It is plain that a of work fitted up in this manner, would prove worthy of the er, when lubricated with clean oil, and if it were properly for, cuts and scratches would be a thing unknown.

e other letter referred to is that of Mr. A. Mertes on "Oil s in Machinery." The trouble he speaks of is encountered day, and, of course, the oil holes and grooves are at (?). This clears us of all responsibility. The oil holes and ves being found faulty, we proceed to remedy this by making he way clear to care for a larger amount of oil and pass the through the extended grooves and thence into the sewer providing the shop in question happens to be without an oil

e reader must excuse my exasperation, but the alteration destruction of machines which the manufacturer and de- r have built in a certain way for a purpose are above all s the most trying. If we have a large bearing with properly il grooves and provided in its pipe with the usual oil wick, should a mechanic expect good results from heavy oil under itions of cold weather. If compelled to use this under the d conditions, good sense should tell him that a dose of ene is needed as often as oil. This applies to the trouble of Mertes. Keep the oil pipe, grooves and journal free from nd lubricate with a moderate amount of clean oil and you never fear a hot or dry journal. Still other evils exist in nachine shop. The back gears of lathes are often misused is the prevailing custom not to fully mesh them together, mably to have them run more quietly. When such gears touch of asthma—caused by an excessive amount of grease gum—the remedy which has already been mentioned is re- d to and for a time appears successful, but conditions re- ing the same, there is sure to be a repetition of the trouble.

ishington, D. C. F. T. Miller.

* * *

## OMETRICAL METHOD FOR ORIGINATING AN INDEX PLATE.

r Machinery:

originate a correct index plate is a difficult undertaking and hat has been the occasion of much thought and experiment. e it is apparently a simple matter to divide a circle into a in number of divisions, the actual difficulties met by any od by which corrections are obtained by repeated trials are ous when perfect accuracy is required. That which would

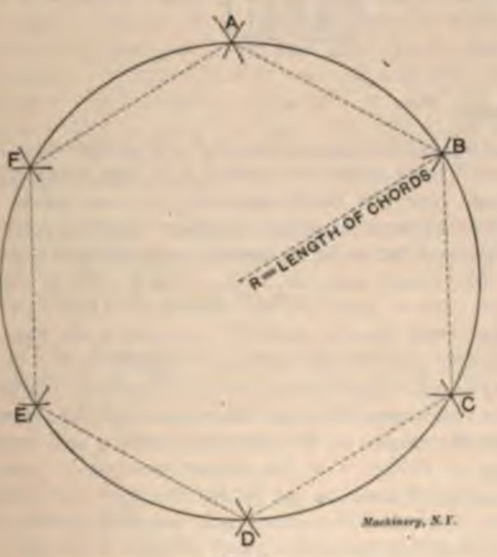

Fig. 1.

ninently desirable for such a process would be a geometri- ethod by which the divisions would be obtained without the sity of corrections for original errors in spacing. In think- omewhat on the subject, the writer has developed the here- described geometrical method for forming index plates of oles, which, although of little practical value, may serve as t by which the formation of plates having a greater number isions may be formed by analogous processes.

The process of dividing a circle into six equal parts as shown in Fig. 1 is familiar to all draftsmen and most machinists and is known to be perfectly accurate, since it is geometrically correct, as is proved in any text-book on geometry. Now, if we can duplicate this action mechanically, the result will be a correct spacing for six holes.

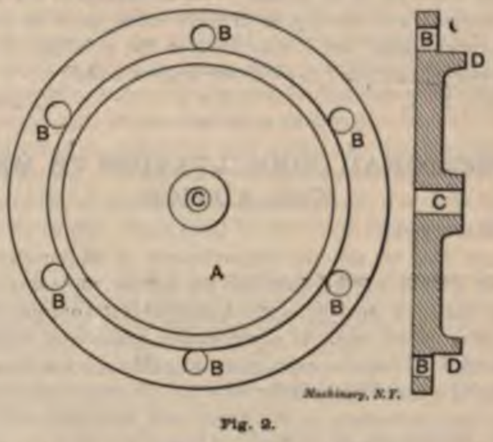

Fig. 2.

To effect this the method illustrated in Figs. 2 and 3 can be used. To form an index plate on a common lathe, it will be necessary to have the swing something over twice the diameter of the circle on which the holes are located. The plate A, Fig. 2, is first turned all over. It has a flange D which should be something less in diameter than the circle touching the inner edges of the holes to be made, and when the flange is turned, the hole C should be bored at the same time and of the same diameter as desired for the index holes. A center is fitted to the lathe arbor and turned on its outer end to a diameter that will depend on the clearance allowed between the flange D and the inner edges of the index holes—say twice 1/16" or ⅛".

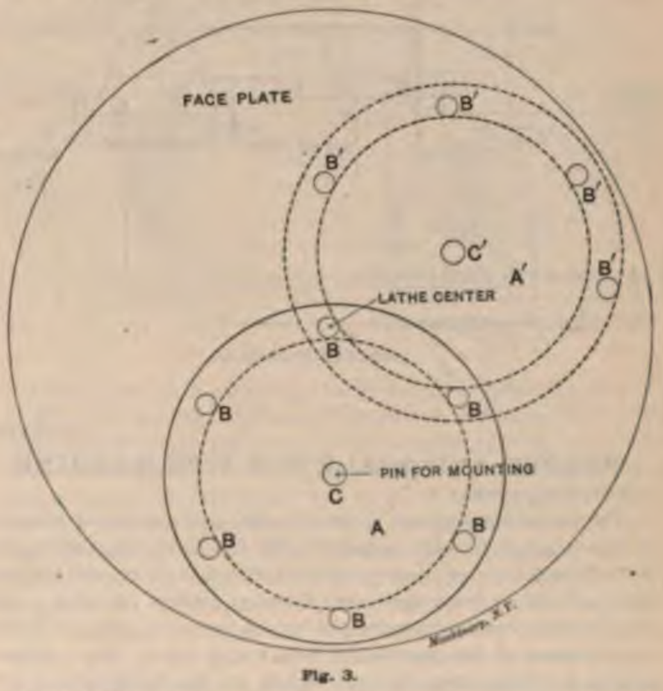

Fig. 3.

A pin C Fig. 3 is also turned to the same diameter as the hole in the center of A and is provided at one end with a shoulder and clamping nut so that it can be engaged in one of the face-plate slots. The index plate is now mounted on this pin and located so that the periphery of the flange D will be against the lathe center which was turned as described. The pin is secured in the face-plate slot and the index plate securely clamped to the face-plate. A hole is then drilled and bored in the index plate to the same diameter as the hole in its center. After the hole is finished, the plate is removed and mounted on the pin C by passing it through the hole just bored. The plate is then swung until the flange D strikes the lathe center and is then clamped fast as shown in Fig. 3. Another hole is drilled and bored to the standard size and then the plate is loosened and swung in the opposite direction until the flange D again strikes the center plug as shown at A'. The operation is repeated as before and the process is continued by "stepping" around until all the six holes are drilled and bored.

It will be observed that the measurements are entirely automatic, the only thing requiring extreme accuracy on the part of the operator being to bore the holes of uniform diameter, which is an operation easily performed. As intimated at the beginning such a process will usually be of little value, as a six-hole index plate is rarely used, but it may be that the principle with modification can be extended to embrace higher numbers.

Newark, N. J. F. Emerson.

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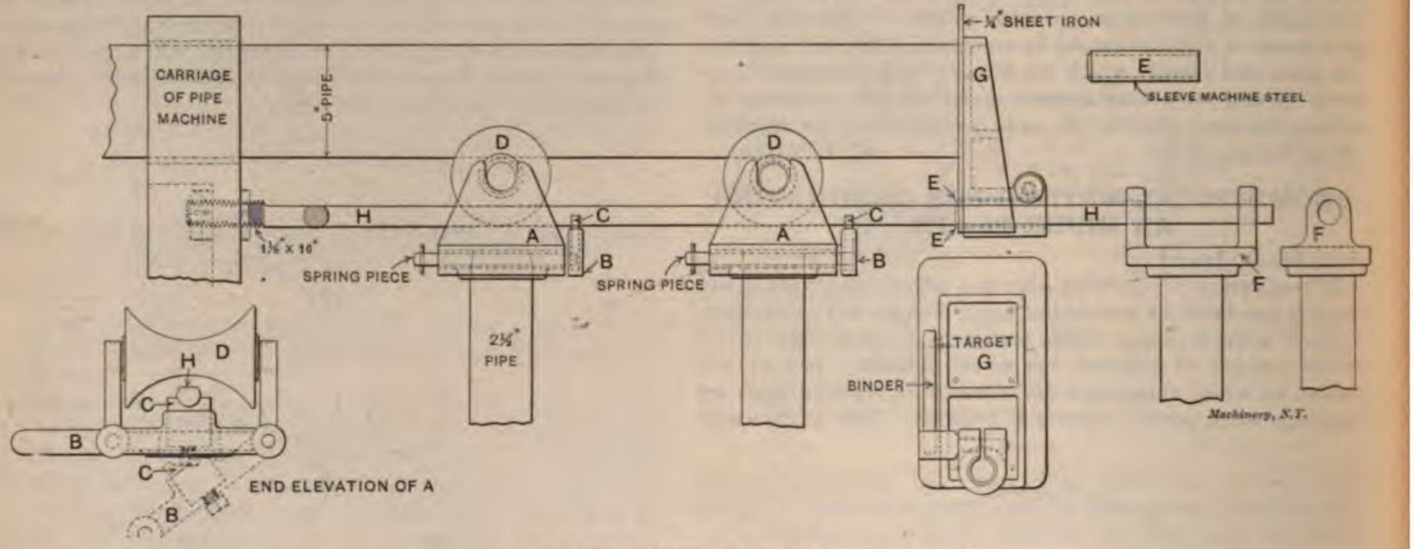
## PROFESSIONAL CONSULTATION VS. MECHANICAL ADVICE.

*Editor* Machinery:

I would like to ask the contributors of Machinery why a mechanic should not be paid for his advice the same as a professional man. I put the same question last summer to a gentleman who stands high as a mechanic, writer and lecturer, and he answered, "I have a case in point. My doctor has often insisted that I should be paid for advice. Now the said doctor was going to put a furnace in his house and he asked me to decide for him which one was the best. I spent six hours looking over the different circulars and gave him my opinion, whereupon he simply thanked me for it."

Now, that gentleman's time was worth as much as that of any doctor or lawyer in the United States, yet because he was a mechanic, he got nothing for his time but thanks, which, in my opinion, is all wrong. J. W. H.

Springfield, Vt.



Attachment for Pipe Machine.

## TARGET AND SCALE FOR PIPE MACHINE.

*Editor* Machinery:

The accompanying cut shows a target and graduated scale for a pipe machine, which together with the following description will illustrate a device or shop kink that has increased the output 30% in its own specialty, namely, cutting off pipe. This increase has been acknowledged by the company and verified by the foreman of the department where it is used. The acknowledgment of the company was shown by the equipment of two other machines with the same arrangement soon after the first.

Referring to the cut, H is a 1⅜" cold rolled shaft 14 feet long milled on one side to ⅞" flat as shown in the elevation A, and graduated to eighths the whole length, except where it passes through the carriage. It is secured to the carriage by lock nuts. G is the target made of cast-iron and faced with ¼" sheet iron. It is bored ¼" larger than shaft to receive the steel sleeve E which has a beveled edge projecting from the face of the target. The sleeve is clamped securely in place by a split boss and binder, as shown, and is kept in position laterally by a small pin in the lower side of the boss. The beveled edge of the sleeve makes it possible to adjust the target very accurately to the graduations on the shaft.

F is an end support for the shaft and is made of cast-iron. D D are cast-iron pipe rolls cast solid. Although shown in the cut with the pipe resting in the bottom of the rolls, they are not intended to take the weight of the pipe when cutting it off, as the pipe machines are provided with powerful chucks, one on each end of the spindle, besides V-guide jaws close to the cutting off tools. These rolls simply catch the pipe when it is cut off, thereby preventing it from falling on the scale and bending it. That these rolls do not support the pipe is further shown by the fact that this machine cuts pipe down to 2", and the rolls have no vertical adjustment. When the pipe is cut off, a laborer stands close to the machine ready to carry it away to the pile. The rolls relieve the man of the sudden weight when large pipe is being cut off, and are removable as shown in the sketch, so as to allow target to pass through. When target is between the carriage and the first roll which is 3 feet away from carriage the man must catch the pipe. This is not so difficult on short pieces, as the speed of machine is slow. It will be seen that a center support was necessary for the shaft H, as it is about 13 feet between bearings, and the rear one is a sliding fit.

The middle supports were arranged as shown in the end elevation of A. B is a cast-iron lever swinging from center O on the back end of the bracket A. It is held in the horizontal position, shown in full lines, in elevation of A, by a spring pin. C is a piece of hard wood 2½" x ½" fitted into a cored socket cast in the lever B, and is adjusted to the shaft by the set screw shown. The swinging down of the lever B with center support C from H allows the target to pass through the roll bracket, and as these brackets are 4 feet apart the shaft can always be supported at one of these points. A A and F are screwed on the end of a piece of 2½" pipe and are flanged to the floor. The whole thing works very smoothly as compared with the old way, which employed a piece of ½" pipe screwed into the carriage at the same point where H is secured. On the ½" pipe was fitted a target with such a fit as was possible to make on ½" rough pipe; the target was held by a set screw. The pipe very soon became indented the whole length by reason of the set screw and had to be frequently replaced with a new piece of pipe. The target was set with a 6-foot sliding rule, making about 11 feet 6 inches when extended. These rules were of wood and must often be replaced by reason of the figures wearing off and they were by no means as accurate as the steel bar, besides having to be set every time a change was made. By having one continuous rule and that of steel all that is necessary is to slide the target to the required position and bind it. The carriage as shown is in the nearest position to face of chuck. End bracket F must be set so that the shaft will always have a support in it when it is in its most forward position, as shown. The carriage has transverse travel of about 16 inches.

This is not as expensive a rig as it might seem, the shaft being bought finished and costing about $1 per foot for graduating. I think it would be hard to beat, for it stands the racket which is considerable. It was after considerable thought that it was decided to make the scale of 1⅜" round shaft, the only other good reliable thing to do being to butt three of Brown & Sharpe's 4-foot scales together and having then only 12 feet and at a cost of about $2 per foot at the least. Then came the problem of holding the scales and sliding the target thereon.

without using a separate slide for the target and a delicate pointer from the target to the scale, continually liable to be bent or broken. With our round scale, however, everything is central with the spindle of machine. It seems to me that this would be a good extra attachment for some builder of pipe machines to add to his standard machine, for it has filled a long felt want in our shop. W. J. H.

Providence, R. I.

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## HOW AND WHY.

### A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

**Give all details and name and address. The latter are for our own convenience and will not be published.**

The following quoted from the U. S. Ordnance Report for 1898 with regard to blueing gun barrels was sent in by Mr. E. S. Parmenter, president of the United States Rifle Implement Co., Bennington, Vt., in answer to question 54 in the May issue.

Boil the parts in caustic soda to remove the grease. For blueing, a cast-iron tank open to the air is employed. The blueing mixture (100 pounds of nitre and 8 to 10 pounds of black oxide of manganese) is raised to a temperature high enough to cause a quick ignition of a pinch of sawdust thrown upon the surface. The cleaned parts are suspended in the center of the mixture in wire baskets suspended from stationary hooks above the pot. They are immersed when cold and are moved about to keep the mixture stirred up. Immerse from five minutes up, depending upon size of parts and shade of color desired. Remove parts from time to time to observe the effects of the treatment in regard to color, etc. After a satisfactory color has been obtained, the parts are plunged into cold water to prevent spotting; next into a vessel of hot water to remove the nitre; then into a vessel of sperm oil to darken and fix the color, and finally into benzine to remove the oil. Wipe dry and the process is complete. The temperature of the blueing mixture should be about 400° Fahrenheit and should be kept well stirred.

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We have also received the following from J. C. Dunn, Montreal, Can.:

In question 54 of the May issue you ask for a cement to fasten leather to cast-iron. It gives me pleasure to send you the following, which I have used with success, and if the job is properly done no rivets will be required. The following ingredients are required: 1 pound best flour, ¼ pound best glue, ½ pound granulated sugar, ½ ounce powdered borax, ½ ounce sal-ammoniac, ¼ ounce alum. Soak the glue in three pints of soft water for 12 hours, or if you have glue already melted pour in the quantity. Mix the flour in one quart of soft water, mix all altogether, and boil over a slow fire, or cook with a steam jet. When cool it is ready for use. The face of the pulley or surface where the leather is to be applied must be thoroughly clean and free from grease.

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62.—"Fountain Pen": Having occasion to solder some pieces of cast-iron I find the ordinary process very unsatisfactory. Please tell me the "secret."

A.—We submit this to our readers.

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63.—I. T. N.: In worm gearing, is the pitch of a double-thread worm the same as the lead? In other words, since, with a double-thread worm two teeth take the place of one large one, does the pitch include two teeth and two spaces?

A.—Yes. See answer to question 57 in the May number.

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64.—E. C. H.: Will you kindly tell me which you consider the stronger, a bicycle frame with head measuring 11½ inches long or with one measuring 5½ inches, the size of the tubing being the same.

A.—A low frame resists sideways deflection and twisting better than a high frame, because, first, the forces act with shorter leverages, and, second, the rear tubing, from each end of the rear hub, is inclined sideways slightly more in the low frame and makes a stiffer brace. Disregarding the side strains, the high frame will undoubtedly support a weight in the saddle with less deflection than will a low one. For practical use, we consider the low frame the stronger and stiffer, provided the head is long enough to give a solid support for the forks.

65.—J. E. O.: Please tell me the difference between emery, corundum and carborundum.

An article by Warren E. Willis was published on this subject in the September, 1899, number of MACHINERY, from which we quote: Emery is obtained principally from the islands of the Grecian archipelago; its hardness depends upon the amount of iron and silica in its composition. It is of the same mineral species as many of the Oriental precious stones, such as rubies and sapphire, but of a dense, opaque, dull bluish or brownish black color. Corundum is a mineral—alumina—remarkably hard, a species of gem stone, of which emery is a variety; it is used as an abrasive in polishing and grinding. Carborundum is an artificial product of the electric furnace acting upon clay; the grains produced are next in hardness to the diamond, being superior to emery. It is used in the same manner as emery.

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66.—M. B. C.: Will you kindly inform me how to calculate the different change gears for any number of threads per inch by combinations of the nest of gears shown in the accompanying sketch of a 60" lathe. The gears D, E, F, G, H and I are never changed, the change gears being J and K. Is there any way that these gears could be compounded to cut a certain thread that could not be cut direct?

A.—The method followed in calculating the number of threads that will be cut with any combination of gears on a lathe as shown does not materially differ from that employed on those having simple gearing, and, in fact, is exactly the same when the pin is engaged with the middle gear of the nest of three gears F, E and D because the velocity ratio from lathe spindle to gear I is then unchanged. Suppose that the pin is engaged with the middle gear E, what will the thread cut be when K has 40 teeth? Since gear B on the lathe spindle has 33 teeth and gear C also has 33 teeth, the sleeve carrying the pin must always rotate at the same rate as the lathe spindle. Now, as the pin is supposed to be engaged in the middle gear E which has 36 teeth, it is evident that the three gears G, H and I will rotate at the same rate as E since H, the driven gear, also has 36 teeth. It then follows that the gear I rotates at the same rate as the lathe spindle when the pin is in the middle position, so all that need be considered, is the relative ratios of I and K. Since K has 40 teeth, the thread cut will be 40 × 3 (number of threads per inch in lead screw) divided by 24 (number of teeth in gear I) or 5 threads per inch. Thus when the pin is engaged with the middle gear the calculation will be exactly the same as for a simple lathe. When the pin is in either of the other two positions, multiply or divide the result found when considering the middle gear as the driver, by the ratio existing between F and G and between D and I. Since G has 48 teeth and F has 24 teeth, the ratio between them is as 2 is to 1. So with K a 40 tooth gear, the thread cut would have twice as many turns per inch as with the middle gear engaged, with F engaged by the pin, or 10. With the pin engaged with D, the ratio would then be as 1 is to 2, therefore, the number of turns per inch of the thread generated would only be one-half as many as on the middle gear, or 2½ turns per inch. You will thus see that if you can cut a certain thread with the middle gear engaged, you can also cut twice as many threads per inch, or one-half as many by shifting the pin. Otherwise such a scheme of lathe gearing offers no advantages over the simple form.

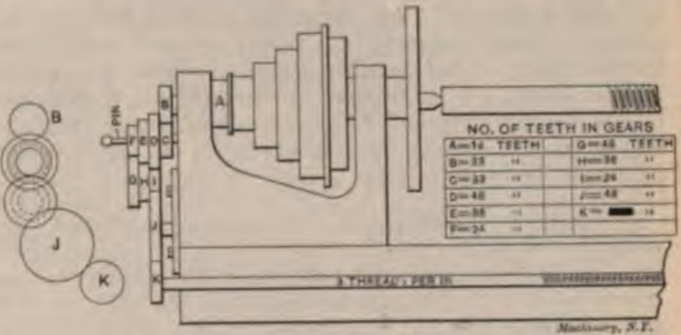

Fig. 1.

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67.—G. G. A.: Can you tell me whether there is a combined steam and gasolene engine and give me the name of the company who manufacture it?

A.—It is possible that some of our readers can answer this question for you. The only engine of this character that we know of is described in one of the early editions of Clerk's "Gas Engine." He describes a Brayton petroleum engine in which the heat from the cylinder walls and the exhaust gases was made to generate steam. This steam was turned into the motor cylinder along with the flame and it was found that the cooling effect of the steam practically balanced any gain that was realized from the increase in volume due to the steam. Clerk estimates that if a separate steam cylinder had been used, about 6% gain in economy might have been realized. Such an apparatus, however, would necessarily be complicated and of doubtful utility. The firm trying the experiment was Messrs. Simon, Nottingham, England.

---

68.—H. W. L.: 1. I recently had an argument with some of the men in the shop over lathe centers. They claim that a 60° center is less acute than a 45° center, also that the angularity of a lathe center is measured by the difference in direction of the lines BC and BA in the sketch. Since in this case the angle ABC is 45°, they claim that the center is properly called a 45° center. 2. At what angle must a lathe tool be set to turn a cone of 30°?

A.—The angle of a lathe center is measured at the apex A and includes the angle BAC instead of being measured at the side, as your friends believe. In the sketch a 90° center is shown by the full lines and a 60° center by the dotted lines. In the latter case the angle is BA'C. You will notice that the angle included between the lines BA and BC is only 45° for a 90° center, while it is 60° for a 60° center, but, as stated, the angle denoting the shape of the center is always measured at the apex. 2. The answer to this question depends on what the angular measurement is to be taken from. If the angle is to be measured by the angular difference between the line joining the lathe centers and the path of the cutting edge of the tool, it would have to be set at 15° in order to turn a 30° cone.

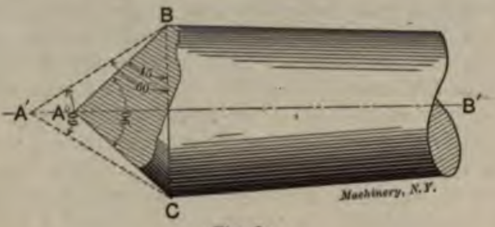

Fig. 2.

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69.—T. H. R.: Will a spur gear of 156 teeth, 12 pitch, roll within an annular gear of 180 teeth?

A.—An external gear of 156 teeth, 12 diametral pitch, involute system, will roll within an internal gear of 180 teeth. A spur gear will roll within an internally toothed gear when the latter exceeds it by at least 12 teeth, when this number marks the gear of the interchangeable series having radial flanks. Gears cut by the Brown & Sharpe system will, however, run together only when the difference in number of teeth of the two gears is at least 15. While an involute tooth for an internal or annular gear should have concave surfaces, they are cut in practice with a No. 1 Brown & Sharpe cutter of the desired pitch, the slight inaccuracy not affecting the practical result. In fact, it makes little difference whether the spur gear flank engages with the annular gear tooth face or not, as it is sufficient to have flank contact in the latter only.

---

70.—C. F. B.: Kindly inform me of the composition of type metal and also of the metal used in the Linotype type-setting machine.

A.—Kent's pocketbook states that type metal is made of lead and antimony, the proportion of the latter being from 17 to 20 per cent. Each type foundry has a composition of its own, which is supposed to be kept secret. Some claim to put in a little copper and others nickel; but the bulk of the metal consists of lead, tin and antimony in varying proportions. Linotype metal is made from lead, tin and antimony in the proportion of 700 pounds of lead, 50 pounds of pig tin and 100 pounds of antimony. This is the formula recommended by the Mergenthaler Linotype Co. They also state that if a hard type face is desired, 5 pounds of antimony and 2½ pounds of tin should be added to the above mixture.

* * *

A leather belt 6" wide, traveling at a velocity of 2,000 feet per minute should easily transmit 12 H. P.

## NEW TOOLS OF THE MONTH.

**Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.**

### MULTI-SPEED EMERY GRINDER.

In the accompanying illustration is an interesting application of the electric motor to independent driving. It shows the Stow multi-speed motor, of which we have previously published a description, adapted to an emery grinder. The machine is designed for two 14-inch wheels and the motor will drive the wheels at any speed from 960 to 1600 revolutions. Starting at the proper speed for these wheels, as they wear away the speed can be increased so that a peripheral speed can be constantly maintained, allowing the emery wheels to always cut to the best advantage.

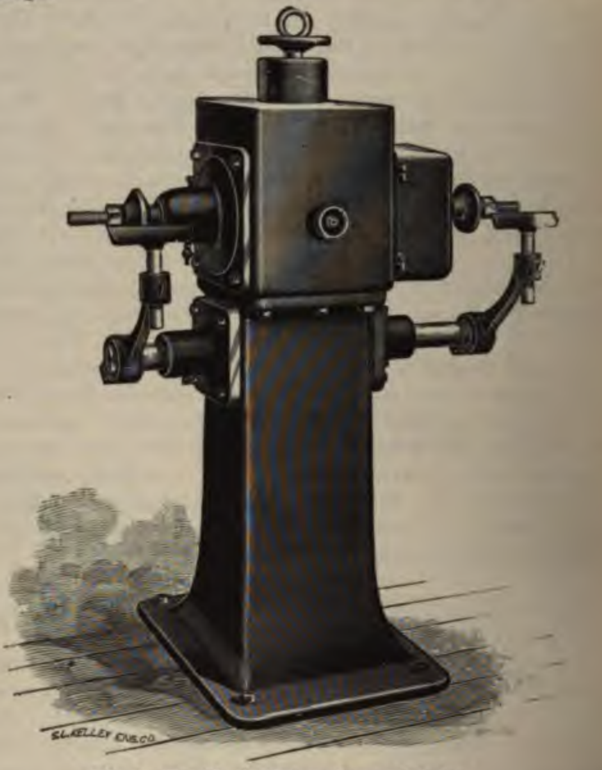

Fig. 1. Electrically Driven Emery Grinder.

It will be noted that the motor is enclosed and dust proof and that the wheels are mounted directly on the armature shaft. This not only makes a simple and convenient arrangement, but the design of the motor is such that the danger from the wheel bursting, due to too high speed, is largely eliminated, because the speed regulating device can be placed entirely within control of the foreman. The speed is varied by moving a core in or out of the hollow pole piece of the motor, which varies the magnetism of the pole piece and so varies the speed of the motor. This core is seen projecting from the top of the motor in the engraving, and it is arranged so that it can be locked and the speed cannot be changed by any one unless he has the key. This machine is manufactured by the Stow Mfg. Co., Binghamton, N. Y., and is one of several applications of this type of motor that they are now manufacturing.

### NEW COINING MACHINERY.

The two machines shown in the engravings on the next page have been made from the designs of Mr. Oberlin Smith, by the Ferracute Machine Company, of Bridgeton, New Jersey. They have been sent to the Paris Exposition, where this company have three separate exhibits.

The machine shown in Fig. 2 is known as a coin-miller. Its function is to take flat "blanks" (discs) of metal, which have previously been punched from the sheet, and mill their edges. This operation consists of thickening up and rounding the edges and is performed by hand-feeding the blanks into one of the slotted tubes shown rising from the table, from the bottom of which they are carried, by the action of feeder-arms, between the externally grooved steel disc, and the segment of an internally grooved steel ring. This segment, known as a jaw, is set somentric to the disc, so that the ever-lessening distance, as t is rolled between the two, will reduce its diameter to er amount. After leaving the jaw it drops through a e table, falling into the box shown beneath.

tomatic feeding of the bottom blank of the pile in the complished very simply by a thin rotating arm mounted top of a small vertical shaft, this shaft being driven by -gear inside the table, which is recessed for the purpose. tion gear is simply a cylindrical disc resting by spring against a similar larger gear mounted upon the main can be instantly thrown out of gear by the small d latch shown projecting through a slot in front of the

be noticed that there are three different tubes, of dif- ees, arranged each one-third of the way around the the older form of machines the table was stationary, tor going to the tube at which he wished to work. In nt machine the table is made to revolve about its own g quickly latched by a small spring bolt in any one of sitions. Thus three sizes of tubes, feeders, jaws, etc., ept mounted for three given sizes of coins or medals, ge from one to the other being almost instantaneous. ed with which these articles can be run through the varies from 200 to 400 per minute.

achine as shown is equipped with an individual electric ounted upon a shelf having an adjustment for taking ngth of belt. Sometimes, however, it is run direct from ing, in which case another form of shipper may be used tage.

illed blanks are known as "planchets," and after leaving miller are ready to be fed into the coining-press, to be coins or medals, as the case may be. The object of two-fold. First, that the sharp corners of the blank may be sufficiently rounded so that the pressure of coining will not quite bring them up to a sharp edge again, as with the ordinary type of coining dies working in a cylindrical collar it is impossible to form smoothly rounded corners. The tendency of the metal under pressure is to flow wherever it can, sometimes going so far as to flow up between the cylindrical part of a coining die and its surrounding collar, so as actually to form thin sharp fins. The second object of milling is to make the edges of the planchet thicker, leaving the main face as a sunken panel, thus giving metal to make the rim which usually forms part of the design of the coin, and which serves to protect the central ornamental parts from abrasion, in cases of sliding over flat surfaces, etc.

The machine shown in Fig. 3 is an automatic toggle-coining press, of the type usually built by the Ferracute Machine Company, with a number of improvements which simplify the feeding and ejecting operations. The ultimate capacity of this machine, in the way of ram pressure, is 250 tons, but for ordinary work, making continuous strokes, it is usually run at a considerably less pressure. It is, however, amply large for coins or medals up to the size of a half-dollar.

By the newly designed arrangement in question, the automatic motions are all obtained from the motion of the ram itself, by means of the rods shown in front of the machine. The device forming the automatic feeder can be removed in a few minutes, thus rendering the press suitable for ordinary hand feeding.

Among other features of this design are the placing of the toggles under the bottom of the ram, instead of in the usual position at the top, thus pushing it upward and forcing the lower die against the coin, the upper die being stationary. One obvious advantage of this arrangement is that no oil or grease can get upon the coins, as all the moving parts requiring lubrication are below the point of operation. Another is the absence of

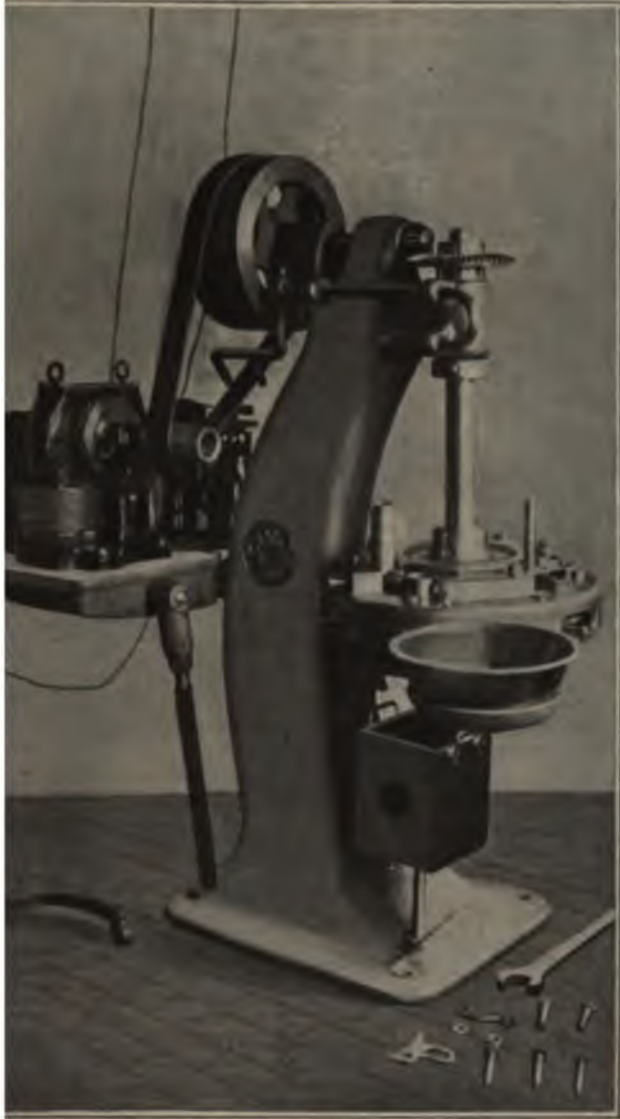

Fig. 2. Coin Miller.

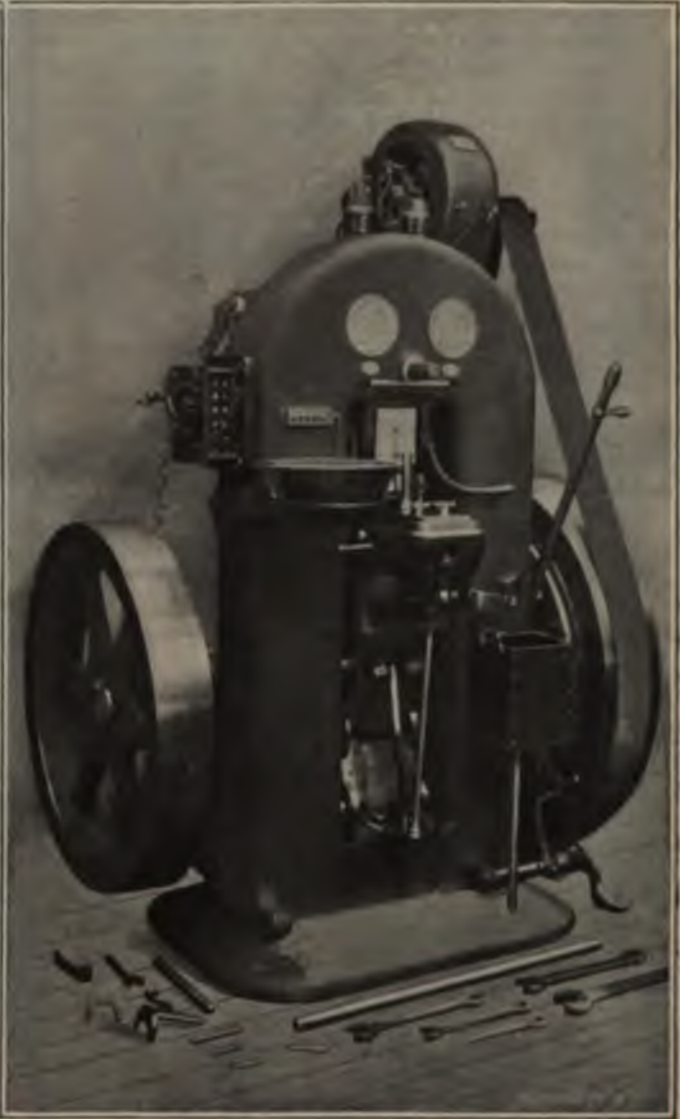

Fig. 3. Coining Press.

"lost motion," as the plunger and the different parts of the toggles are held close together by gravity, while in the case of the upper toggles generally used, gravity tends to pull everything apart, and cause a lost motion which is calculated to damage the dies, and to make a rattling noise when running.

Another unique feature is the fastening of the upper die to an oscillating head, which can, in a fraction of a second, be swung forward and upward by means of the two handles shown in front of the machine, one of which unlocks this head and the other of which raises it. This allows an unusual convenience of access for inspection and cleaning of the dies, an access which is generally obtained by an unnecessary long die stroke of perhaps a couple of inches. In this case the stroke of the die approximates ½", which short stroke not only allows the coin to be confined so that it cannot jump out of place, but causes much less wear upon the machine than usual, with consequent durability. It also insures a minimum of noise, and enables the press to be run considerably faster than is customary. The feeding devices are also arranged with a very short stroke.

This press is equipped with a friction clutch, operated by the handle shown at the right, and is driven with an individual electric motor, duly provided with a rheostat, as shown respectively at the top of the machine.

### EXPANDING MANDREL.

The Western Mfg. Co., Springfield, Ohio, have brought out a neat expanding mandrel called the "Champion," which is shown in the accompanying illustration. It consists of two parts, one of which is a sleeve, tapered inside and split longitudinally in several places, as indicated in the illustration, and the other of which is a taper arbor to be driven into the sleeve, thus expanding it. It will be observed that the arrangement of the slots in the sleeve is such that it is very flexible and will conform closely to the cylindrical form, even when expanded to quite an extent. Both parts are of tool steel, hardened and ground. The sleeve, being shorter than the arbor upon which it fits, allows overhanging when facing, thus obviating the liability of cutting into the mandrel. The taper is such that the mandrel is easily released and yet it will hold the work securely.

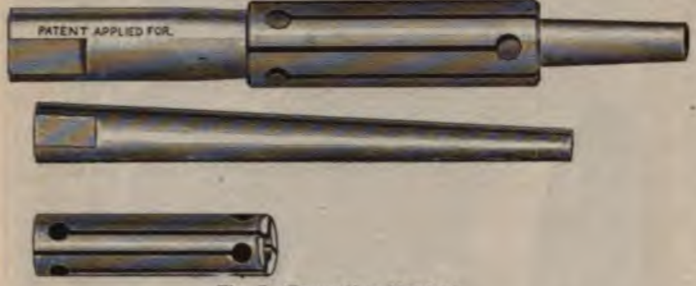

Fig. 5. Expanding Mandrel.

### CONSOLIDATED SPEED CONTROLLER.

The principle on which the device operates will be understood by referring to the sectional cut Fig. 5. Two opposing discs A B are mounted on the shaft, one being secured to the shaft S and the other to the sleeve Q. The discs A B are of such shape that when in the position shown, the space between them on each side of the shaft is of circular section. Between the discs are mounted suitable rollers C C which transmit motion from one disc to the other. Thus if the power is being transmitted through the pulley G and the shaft S, the disc B will be the driver and the disc A will be driven in the opposite direction and at a speed ratio that will depend on the angular position of the friction rollers C C. If they be in the position indicated by the full lines, it is evident that A will have a slower angular velocity than B, since the motion of B is transmitted from a surface having less than one-half the radial distance from the center of rotation as that of A to which motion is transmitted. On the other hand, if the friction rollers are in the position indicated by the dotted lines marked C′ C′, the angular velocity of A will be greater than that of B, as the conditions are reversed. If the rollers C C be shifted so that their sides stand parallel to the shaft, the angular velocity of both discs will be the same, as motion will be transmitted between equi-distant surfaces.

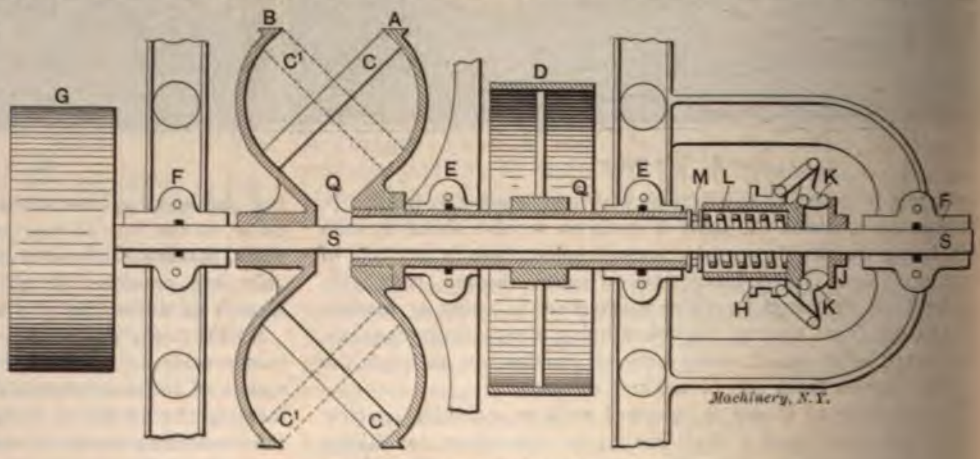

Fig. 5. New Variable Speed Device.

The end thrust caused by the pressure necessary on the friction rollers is taken on a ball bearing at M, and the pressure is maintained through the medium of a coil spring L. To throw the device into action, the clutch collar H is moved to the left, which action operates the levers K K and produces a powerful end pressure between the sleeve carrying the coil-spring and the collar J, which is solidly attached to the shaft S.

To vary the speed, a lever not shown is used by which the rollers can be turned from the position indicated by C C to that indicated by C′ C′, thus giving any desired ratio between 7 and 1. Thus if the pulley G were driven at 210 turns per minute, the rotations of D could be varied from 80 to about 560. In some sizes, however, the ratio of change varies between the limits of 1 and 10.

The wide field for variable speed devices is well known and needs no specific mention here, but one use can be specified in which the great gain is well worth noting, and that is in transmitting power to high speed machinery. It is well known that to get many machines, like extractors, to running at top speed is an operation requiring some caution on the part of the operator to avoid breaking or running off of the belts. In any event the time taken is considerable, as the slipping of the belts is so great that the acceleration is slow. With a variable speed device, however, the starting of high speed machinery is a simple matter, and can be effected in a fraction of the time ordinarily required, as there need be no slipping if the operator properly manipulates the controller.

The Consolidated speed controller is made by the Consolidated Machine Specialty Co., 185 Franklin Street, Boston, Mass.

### WARM WEATHER FANS.

The electric disc fan has become established as a local cooling device for summer use, but its ability is limited to merely stirring up a breeze. For the actual movement of air to or from buildings or through ducts a different type is required. The B. F. Sturtevant Co., of Boston, Mass., are now building a type of electric propeller ventilating fan such as is shown in Fig. 6, on the next page, which meets the latter requirements.

The fan wheel is carefully designed to act against reasonable resistance and to move the air in lines parallel to the axis of the shaft. It is contained within a special circular frame casing which is conoidal in its form as it approaches the circumference of the wheel. This results in decreasing the resistance offered to the entering air. The frame carries a tripod support with annular center within which is accurately placed and centered a bi-polar motor, consisting of a circular field ring to which the pole pieces are attached. Extending out from either side of the field ring is a yoke which contains the ring oiler bearings. The bearings are self-aligning and self-oiling, and fitted with composition sleeves which are removable from the outer end of the boxes.

Hard carbon brushes carried in holders of a modified reaction type are employed and permit of easy adjustment when

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it becomes necessary to reverse the direction of rotation of the motor. Special light end casings with removable centers are provided, which when applied and bolted in place entirely enclose the motor, thereby absolutely protecting it from dust. This is a most important feature in a machine of this type where the air possibly laden with dust is drawn directly across it. The movement of this air is of great service in maintaining a low temperature of the surface, while the motor itself is designed to avoid excessive heat. This motor is capable of continuous operation for 10 hours with a maximum temperature rise which does not exceed 60 deg. F. The entire apparatus is ordinarily shipped complete and may be bolted directly to an opening in the wall through which the air is drawn or forced. These are built in sizes from 18" to 120" in diameter with capacities ranging from 2,000 to 175,000 cubic feet per minute and driven by motors ranging from 1-6 horse-power to 14 horse-power.

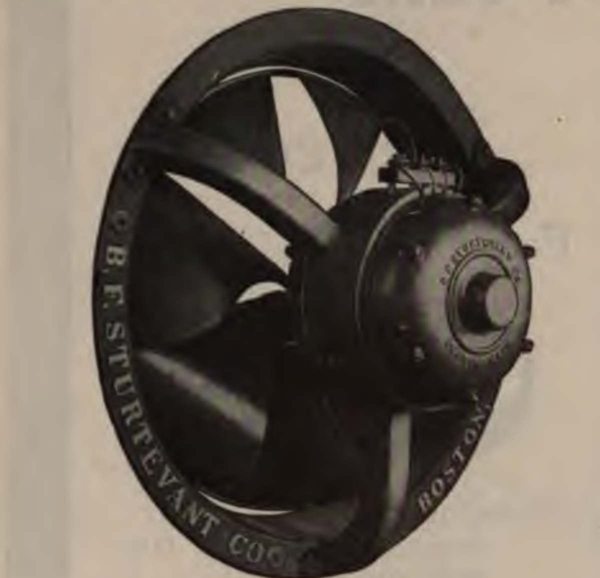

Fig. 6.

### THE STANDARD ADJUSTABLE CHUCKING REAMER.

This tool is intended to meet the requirements of general machinists and electrical repairers. The main body of the tool is one solid piece of steel and the original centers on which the reamer is ground are retained.

The blades are of tool steel, carefully hardened. It will be noted that the back ends of the blades are beveled and clamped securely to the body of the reamer by a lock nut, while the front ends are notched to give a bearing for the points of set screws which clamp the front ends of the blades. There is a wide range of adjustment, 1-16th of an inch being allowed for wear and regrinding, and the reamer has but few parts. The blades are interchangeable and can be replaced when worn to their limit, thus obviating the cost of an entire new tool. It is made by the Standard Tool Co., Cleveland, Ohio.

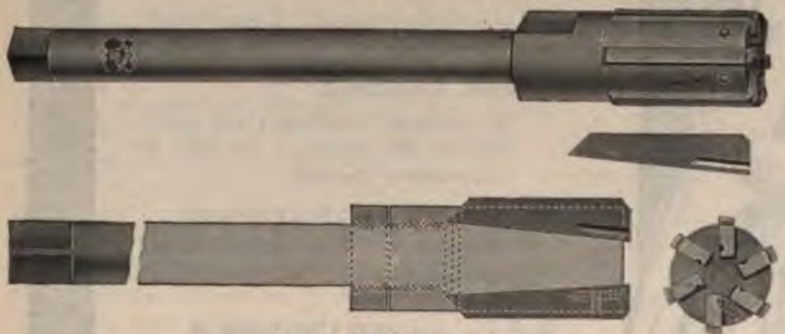

Fig. 7. New Expanding Reamer.

* * *

### FRESH FROM THE PRESS.

Practical Treatise on Gearing. Sixth edition. Published by Browne & Sharpe Mfg. Co., Providence, R. I. 158 pages and 71 cuts.

The sixth edition of the Treatise on Gearing is a revision of the matter that has previously appeared to which is added a chapter on cutting spiral gears in the universal milling machine. The rapidly extending use of spiral gears makes this chapter very appropriate. It is, perhaps, superfluous, but an assurance to many prospective readers to state that the treatise as a whole is adapted for the practical mechanic who has neither the time nor education to appreciate the rigorous mathematical treatment accorded this interesting subject by many books on gearing, but who can understand ordinary arithmetical calculations.

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The Technic of Mechanical Drawing. By Charles W. Reinhardt, Chief Draftsman of the Engineering News. Published by the Engineering News Publishing Company, New York. Price $1.00.

The book contains eight chapters besides ten plates that are exceptional specimens of the draftsman's art. All the cuts shown are photographed from the originals and they are an incentive to the young and ambitious draftsman who desires to master the art of making fine drawings. The chapters take up in order: Outlining, Outline Shading, Section Lining, Curved Surface Shading, Shading of Inclined Surfaces, Map Drawing and Character and Finish. The work is better adapted to the needs of the young civil engineer or architect than for those connected with the machine shop.

### ADVERTISING LITERATURE.

We have received from the Sterling Emery Wheel Mfg. Co., Tiffin, Ohio, a price list of their emery and corundum wheels. The pamphlet contains a table of safe speeds for emery wheels, and other information.

The New Process Raw Hide Co., Syracuse, N. Y. Catalogue of New Process raw hide gears; pocket size. A large number of gears of different dimensions are listed in this catalogue, as well as some other raw hide specialties, such as bushings and hammers.

A standard size catalogue of upright drills for both heavy and light work has been received from the Cincinnati Machine Tool Company, Weston avenue and Dayton street, Cincinnati, Ohio. This line of drills is new and is clearly described and illustrated in this catalogue.

The Prentice Bros. Co., Worcester, Mass., have issued a pocket size catalogue of their upright and radial drills and lathes. It contains illustrations and descriptions of the numerous styles and sizes in which their tools are made.

We have received from the J. H. Williams Co., manufacturers of drop forgings, Brooklyn, N. Y., a new catalogue in which a number of products are listed that have not previously been shown. Among these are a line of drop forge socket wrenches, a regular line of valve stems, rod ends and crank shafts, which are carried in stock, a line of straight tail dogs, a line of hoist hooks and automobile forgings.

Hill, Clarke & Co., 156-164 Oliver street, Boston, Mass., and 12-14 South Canal street, Chicago, Ill., have a very attractively arranged and printed catalogue of drilling and boring machines. A line of drills for all purposes is shown and the boring machines include the horizontal and vertical types. A few other machines such as planers and shapers are also listed, and the catalogue will be found convenient for reference by any one interested in machine tools.

MACHINERY.

August, 1900. No. 12.

# A FEW PRINCIPLES OF ORNAMENT.

W. H. SARGENT.

st every manufacturing establishment there are times
rnamental design is required and it is not always that
cal draftsman can be found who has the necessary taste
uisite acquaintance with the fundamental principles of
do justice to the undertaking. There are bases and
nd brackets to be designed, or an ornament may be
cover a flat surface; a gate may be ordered formed
lat or round rolled iron and the draftsman is apt to feel

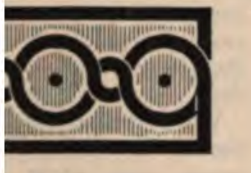


Fig. 1.

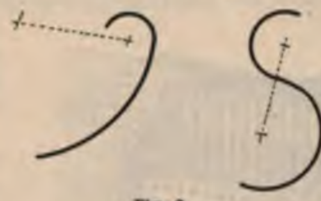


Fig. 2.

he can handle straight lines and circles such as come
aily work, yet he is not capable of attempting free-
ns. As a matter of fact, the more the work is com-
traight lines and circles, the more it is capable of be-
ted by fixed principles. These principles have come
generations of designers as being necessary to satisfy
d gratify the taste in matters ornamental—a sort of
ost to which the designer must tie his imagination.

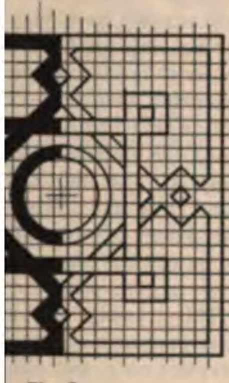


Fig 3.

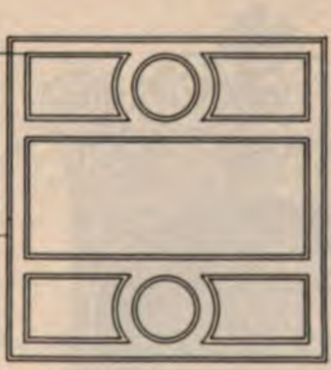


Fig. 4.

ying principle of ornament is variety, and the law of
variety leads us to consider the mixture of straight
lines as a necessary condition of beauty.

cal designs are produced by arranging and joining
dots and repeating or dividing and subdividing in
with the laws of symmetry and regularity. The
he first geometric figure to present itself, the hardest
d the least used. While in equity, matters should be

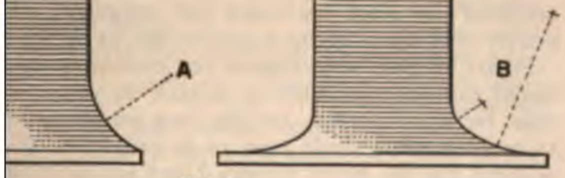


Fig. 5.

as they are long," this principle will not hold in de-
bject should be longer than it is high, as in Fig. 1,
hould be three to five times taller than it is wide, as
To treat a square successfully it should be so divided
circles or by diagonal lines as to relieve its lack of
g. 3). By dividing its space into several panels it
de to appear longer or wider than it really is, as
ig. 4. A picture having the height and width equal
leasing proportion. A cube is subject to the same
laws as a square, and should be avoided if possible. A shaper is not so graceful looking a machine as a lathe or an upright drill, since its dimensions are contained within the outlines of a cube, while in the case of the other machines the height and width are unequal. But "handsome is that handsome does," and we overlook appearances because of the obvious utility of the machine. The circle is the most useful fundamental form in ornamentation, not so often alone as in curves which are made up from parts of circles. The most natural subdivisions of a circle are on radial lines and from these, as centers, other intersecting circles may be struck, producing an effect resembling the decoration of watch cases or the elaborate work on bank notes produced by the geometric lathe.

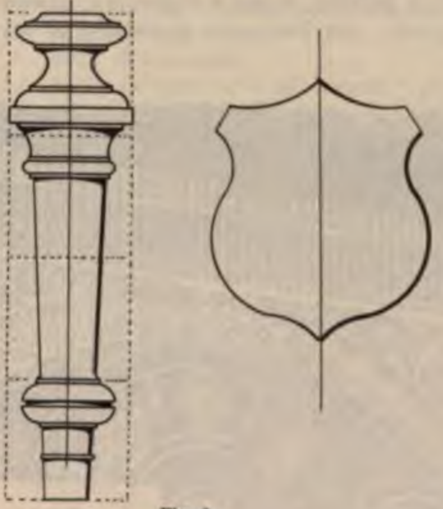


Fig. 6.

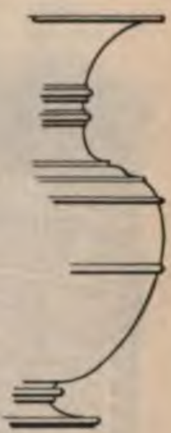


Fig. 7.

Where the arcs of two circles join together to form a curve, they should not be of the same radius; moreover, the two centers and the point of junction should be in the same straight line, Fig. 2. This is necessary in order to give sufficient variety to the design, and although we may not always notice it, yet we see it daily. Take the letter S and you will see that the top part is a smaller circle than the lower half. Turn the letter over and the difference at once becomes apparent. An ellipse is to be preferred to a circle because of the greater variety of outline and proportion since it is made up from circles of different radii.

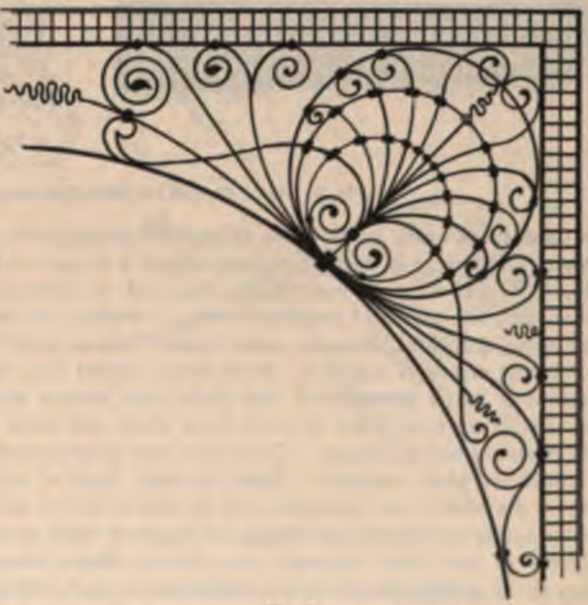


Fig. 8.

Fig. 5 shows a design for a base suitable, say, for a milling machine. In the sketch marked A the curve is formed by the arc of one circle, while sketch B shows a more graceful curve formed by the arcs of two circles of two different radii. It is a general rule that every long line should be interrupted—a straight line by short curves, a curve by other curves of different radii or by short straight lines, as in Fig. 7. In these days of steel and iron, when the song of the rolling mill is heard throughout the land, the use of wire and rods in decorative work has greatly increased. Wire fencing is turned out by the mile, cheap and substantial, not the ugly barbed variety, but beautiful in design. Wire enclosures for elevator cabs, Fig. 8, are now formed up entirely of that same wire which, in unskilful hands, is so capable of producing commonplace or inartistic effects. This fascinating work is now taught in the schools, where soft annealed wire and round-nosed pliers are used, and as "Venetian Iron Work" it is something of a fad among amateurs. The beautiful gate of the Mills Building, shown in Fig. 9, is a "grown up" example of this work. Just how much decoration to bestow upon metal work would seem to be determined by its purpose and that design is best which best adapts it for the end intended. Do not make up your composition out of short, jerky, disconnected or unrelated fragments like a medley in music. Have some dominant thought, some "motif" which shall bind the different members together. Make first a center line, if the ornament is to be symmetrical and build your design around that. Divide up your space by cross lines which will serve as a guide in laying out the design. Ornament your construction, do not construct your ornament. Have in mind, first of all, the utility of the object, the handiness, and having made the general outlines conform to these conditions, clothe them with as much ornament as your best judgment may direct. Study the catalogues of the manufacturers of ornamental metal work, the stove makers, wire mills, sheet metal pressers, and the designers of locks and door trimmings and builders' hardware—they are an education in themselves. If you wish for a moderate priced book on this subject see Meyer's Handbook of Design. This is published in New York and although I am not authorized to say so, yet I presume it could be obtained through the book department of the Industrial Press.

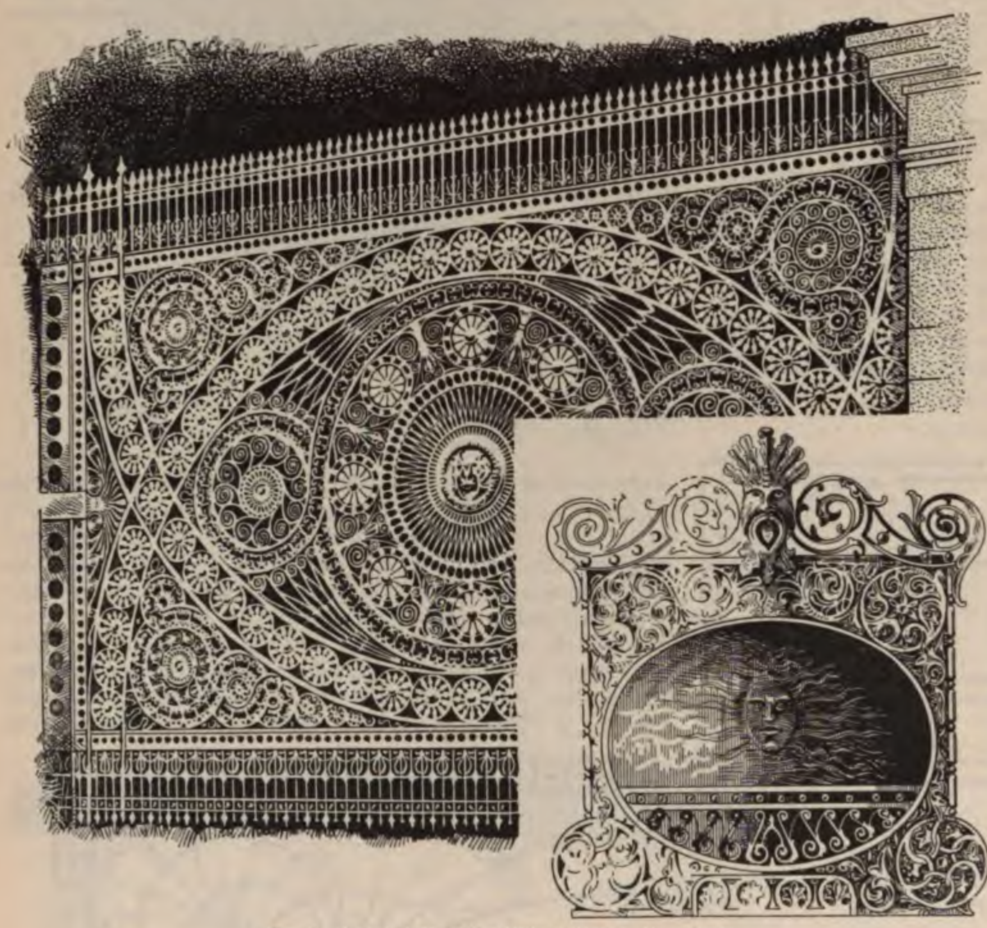


Fig. 9. Metal Gate of the Mills Building, New York.

## THE NEW YORK HARBOR FIRE.

Previous to the burning of the wharves and of three of the vessels of the North German Lloyd line at Hoboken, N. J., on the last day of June, it would have seemed inconceivable that so terrible a tragedy could have occurred under such circumstances. The possible destruction of from five to ten million dollars in property and of from 150 to 200 lives, within the space of a few hours, while the vessels containing the fated victims were lying at their docks, was not foreseen by any one. Now that the calamity has happened, however, the causes are very obvious, and, in fact, the conditions were such and are now such at hundreds of other wharves in this country and elsewhere, that it would seem inevitable that just such an event must have transpired in the natural course of things, at some time and some place.

The progress in recent years in the ways and means of keeping fire under control is marked, and nowhere is a better example of this to be found than on board a modern Atlantic liner. The steel hulls and water-tight compartments make it possible to confine any ordinary fire to a limited space, which can be flooded by the pumps in a short space of time.

When the conditions are reversed, however, and the fire comes from above while the would-be fire fighters are below, the very arrangement that ordinarily makes a vessel a place of safety converts it into a veritable death trap. This is what happened at the Hoboken fire. The wharves which, with their buildings, were mere tinder boxes fanned by every breeze that blew, were stored with cotton and other inflammable material; and when from some unknown cause this material ignited, it was but a few moments before the whole was ablaze and the flames had enveloped the frail upperworks of the vessels. The only avenues of escape from the hulls led through the flames above, and those below could not have been confined in a more secure prison.

This tragedy reminds us anew that progress comes through experience only, and often bitter experience, such as this. Nowhere is this fact truer than in engineering in its various branches. It required many years of disaster at sea to teach men to build vessels that could travel from port to port in safety. It was only by the destruction in the Spanish war that naval constructors learned to fully comprehend that battle ships with wooden fittings are more dangerous to their defenders than to those attacking; and now, let us hope that the lives so recently sacrificed will teach the lesson that safeguards are needed to protect lives and property in port as well as on the open sea.

In fact, in port, when engines and machinery are being overhauled and are unavailable for moving the vessel, or even, possibly, for fire protection, and the crew are not on regular duty, extra precautions would seem to be called for. It is now announced that the North German Lloyd will build new wharves, of stone, with fire proof buildings. This is a good beginning for a new order of things, and should lead to many other changes for the safety of life and property.

* * *

Two months ago a fire insurance expert estimated that the losses from fire during the year 1900 would reach the enormous figure of $175,000,000. It now appears that this estimate will be considerably exceeded, as the loss for the first six months was nearly $100,000,000. Such waste is deplorable, as it represents the total destruction of human effort with absolutely no return.

## SOME USEFUL RULES FOR THE SHOP.

### THE PRINCIPLES OF GEOMETRY APPLIED IN PRACTICAL SHOP WORK.

I. McKim Chase

The following problems are frequently met with in the workshops of various trades, especially in pattern making. They are readily solved with the aid of a few figures, and the rules for doing so are easily applied, and require no higher knowledge of mathematics than that of arithmetic.

Probably the problem most frequently encountered is to find the radius of an arc of a circle that will intersect three given points. See Fig. 1. It can be found by the following rule: Divide the square of half the chord by the versed sine, or height, and to the quotient add the versed sine. This sum will then equal the diameter. Example: Let the chord of the arc equal 60 inches and the versed sine 10 inches; required the radius.

*Fig. 1.*

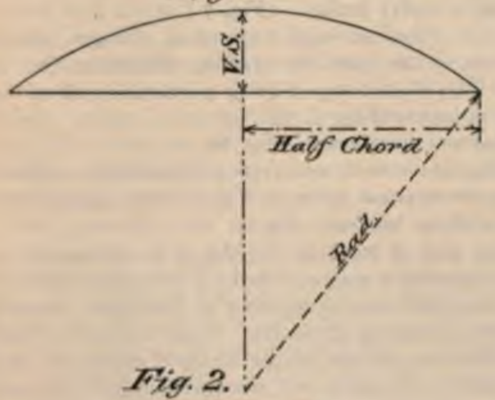


*Fig. 2.*

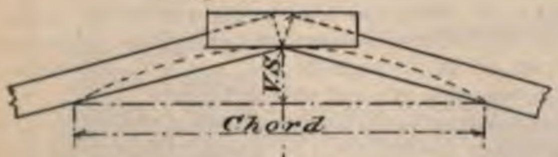
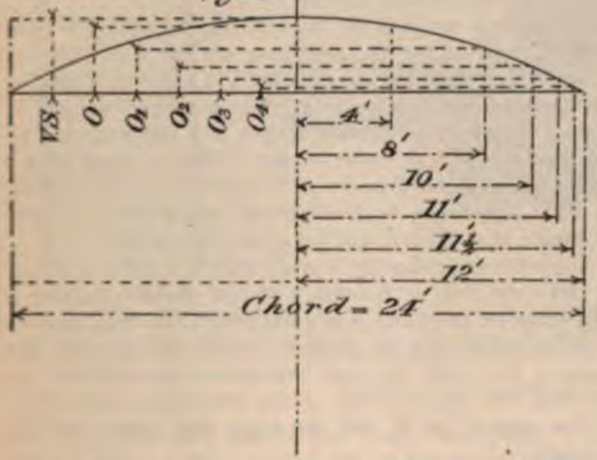


*Fig. 3.*



One-half the chord .......................... 60/2 = 30 inches
The square of half the chord................30 × 30 = 900 inches
Square of half chord divided by versed sine... 900/10 = 90 inches
Diameter equals .......................... 90 + 10 = 100 inches
Radius equals .............................. 100/2 = 50 inches

If it should be found inconvenient to describe the arc with trammels in consequence of the circle being very large or the center inaccessible, it may be described as follows, when the chord of the arc and versed sine are determined: Drive a wire brad at each extremity of the chord and also at the end of the versed sine. Then provide two straight edges; the length of each must not be less than the length of the chord. Let the straight edges bear against the brads at the ends of the chord, and one end of each bear against the brad at the end of the versed sine. In this position secure the straight edges together. Now withdraw the brad at the end of the versed sine and insert a scriber in the apex of the angle formed by the straight edges. By moving the templet to the right and left while bearing against the brads at the ends of the chord, the desired arc will be described. Fig. 2.

When it is inconvenient to describe the arc by either of the foregoing methods, it may be arrived at by laying down the arc to a scale, erecting ordinates from the chord and from the dimensions thus obtained develop to full size. But if greater accuracy is desired than is obtainable by this method, the arc may be determined by computing the length of the ordinates. The chord can be laid down full size, the ordinates erected from it and with the aid of a batten intersecting their extremities, the arc can be described. Fig. 3.

Let the diameter equal 304 feet.
Let the chord equal 24 feet.

In this case the first dimension to be found is the height of the versed sine, which is determined by the following rule: Subtract the square of half the chord from the square of the radius and extract the square root of the difference; subtract this root from the radius and the remainder equals the versed sine. Example:

Radius equals .................... 304/2 = 152 feet
Half chord equals ................ $\underline{24/2 =}$ 12 feet.
$152^2 - 12^2 = 23104 - 144 = 22960.$ $\sqrt{22960} = 151.5256.$
Versed sine = 152 − 151.5256 = .4744 feet.

The versed sine being determined, the ordinates are found by the following rule: Locate the distance of the ordinates from the versed sine. Subtract the square of this distance from the square of the radius and extract the square root of the difference. Subtract the versed sine from the radius and then subtract this remainder from the root previously found, and the remainder is the required ordinate.

*Fig. 4.*

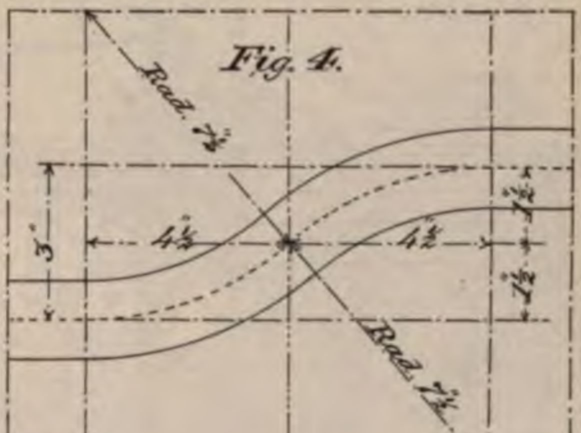
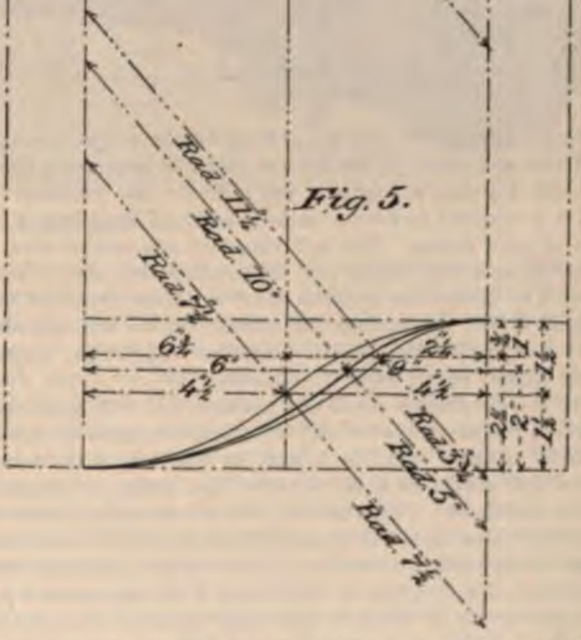


*Fig. 5.*



The difference of the versed sine and radius will be a constant in finding all of the ordinates.

As the distance from the versed sine is increased and the end of the chord is approached, accuracy is enhanced by diminishing the distance between the ordinates. Example:

$$\begin{array}{l} 152^2 = 23104 \\ \phantom{15}4^2 = \underline{\phantom{231}16} \\ \text{Diff.} = 23088 \end{array}$$

$\sqrt{23088} = 151.9473$

$152 - .4744 = 151.5256$

$151.9473 - 151.5256 = .4217$ ordinate.

Similarly the other ordinates are determined.

$\sqrt{152^2 - 8^2} - 151.5256 = .2637 = o_1$

$\sqrt{152^2 - 10^2} - 151.5256 = .1451 = o_2$

$\sqrt{152^2 - 11^2} - 151.5256 = .0758 = o_3$

$\sqrt{152^2 - 11\tfrac{1}{2}^2} - 151.5256 = .0387 = o_4$

Another problem frequently met with in laying off work is to form an offset; that is, to join two parallel lines with a compound curve either by employing two different radii or a similar radius for both sides.

Fig. 6.

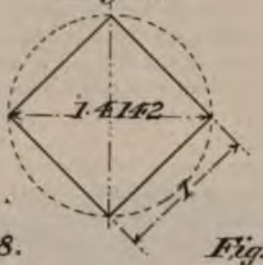


Fig. 8.

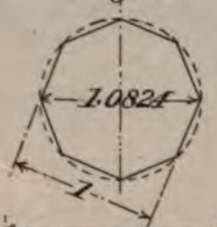


Fig. 7.

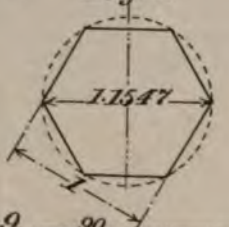


Fig. 9.

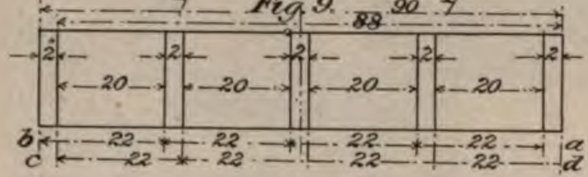


Fig. 10.

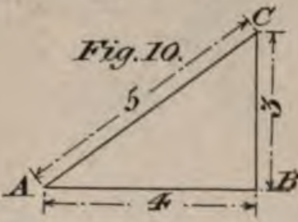
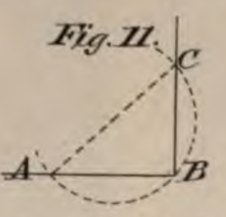


Fig. 11.



Having acquired the rule for computing the radius when the versed sine and chord of the arc are given, it becomes a simple matter for any one to compute the radii for this problem. In Fig. 4 it is required to have a uniform offset of three inches in a length of nine inches. The half chord is one-half of nine, or 4½ inches, and the versed sine is one-half the offset, or 1½ inches. The center line of offset must be joined first, and from the centers thus determined the outside curves are described. By the rule given, Fig. 1, the diameter $= 4.5^2/1.5 + 1.5 = 15$ inches. Radius equals $15/2 = 7\frac{1}{2}$ inches.

There is a peculiarity anent this problem that will repay those who are unacquainted with and who have occasion to solve it to become familiar with. It is that for like offsets the sum of the radii will always be equal, whether two similar or dissimilar radii are employed. For instance, it is shown (Fig. 4) that for an offset of three inches in nine, with similar radii of curvature, the sum of the radii is 15 inches. If it should be desired to have one radius twice as great as the other, it is only necessary to take 2/3 of 15 or 10 for one radius and 1/3 of 15 or 5 for the other (Fig. 5). Or if it is desired to divide into ¾ and ¼, the radius will be respectively 11¼ and 3¾. This principle is graphically illustrated by Fig. 5.

There are many other such problems as the foregoing that are frequently met with in laying off work, and for the solution of which the cut-and-try method is employed, when by the use of a little arithmetic with a knowledge of the principles involved, a solution could be obtained more readily.

Let it be required to cut a square out of a round stock, as in the case of a nut where a part of the length is cylindrical and a part square, the length of the side of the square only being given. To find the diameter to turn the cylinder, the majority of workmen would lay down the square and measure across the corners; but it can be computed more readily by the following rule: Multiply the length of side by 1.4142 and the product is the distance across the corners, or the diameter of the circumscribing circle. Example: The side of a square is 3 inches; required the diameter of the circumscribing circle.

$3 \times 1.4142 = 4.2426$ inches. See Fig. 6.

If instead of a square, it is desired to find the circumscribing circle of a hexagon use the following rule: Multiply the distance across the sides by 1.1547. Example: The distance across the sides of a hexagon is 3 inches; required the diameter of the circumscribing circle.

$3 \times 1.1547 = 3.4641$ inches. (Fig. 7.)

To find the circumscribing circle of an octagon, multiply the distance across the sides by 1.0824. Example: The distance across the sides of an octagon being 3 inches; required the diameter of the circumscribing circle.

$3 \times 1.0824 = 3.2472$ inches (Fig. 8).

A problem of common occurrence is to divide a given length into a number of equal parts, each part being separated by some object as a rib or bracket. Fig. 9.

The usual way of working out this is to repeatedly try until the desired spacing is accomplished. I have found the following to be a convenient way of arriving at the proper spacing when the ribs are of uniform thickness. From the entire length subtract the thickness of one of the ribs and divide the remainder by the number of spaces, and the quotient will be equal to a space and a rib. With this distance begin at the inside edge of one of the ribs, as at a, and step off, terminating at the outside edge of the rib at the opposite end, as b. Then reverse this operation, beginning at c and terminating at d.

Example: A length of 90 inches, having 5 ribs 2 inches thick, is required to be divided into 4 parts and the ribs to be of equal distance apart.

$90 - 2 = 88$

$88/4 = 22 =$ the distance to step off with.

Of the various methods of constructing right angles without the aid of a square, the two following are the most convenient (Fig. 10). A triangle having its sides 3, 4 and 5 in length or in this proportion has one angle at right angles. Lay off A B equal to a length of 4. With a length of 5 and with one point of the dividers at A describe an arc. With a length of 3 and with one point of the dividers at B, describe another arc at C. Draw right lines from the intersections of the arcs to A and B. The triangle thus formed will have one right angle.

An angle circumscribed by a semi-circle is a right angle (Fig. 11.) Draw the line A, B. Set a pair of dividers to any convenient distance and, with one point above the line, describe a semi-circle intersecting the point B and the line between A and B; draw a line from this last intersection through the center intersecting the opposite side of the semi-circle at C; draw a right line from C to B, and the angle thus formed will be a right angle.

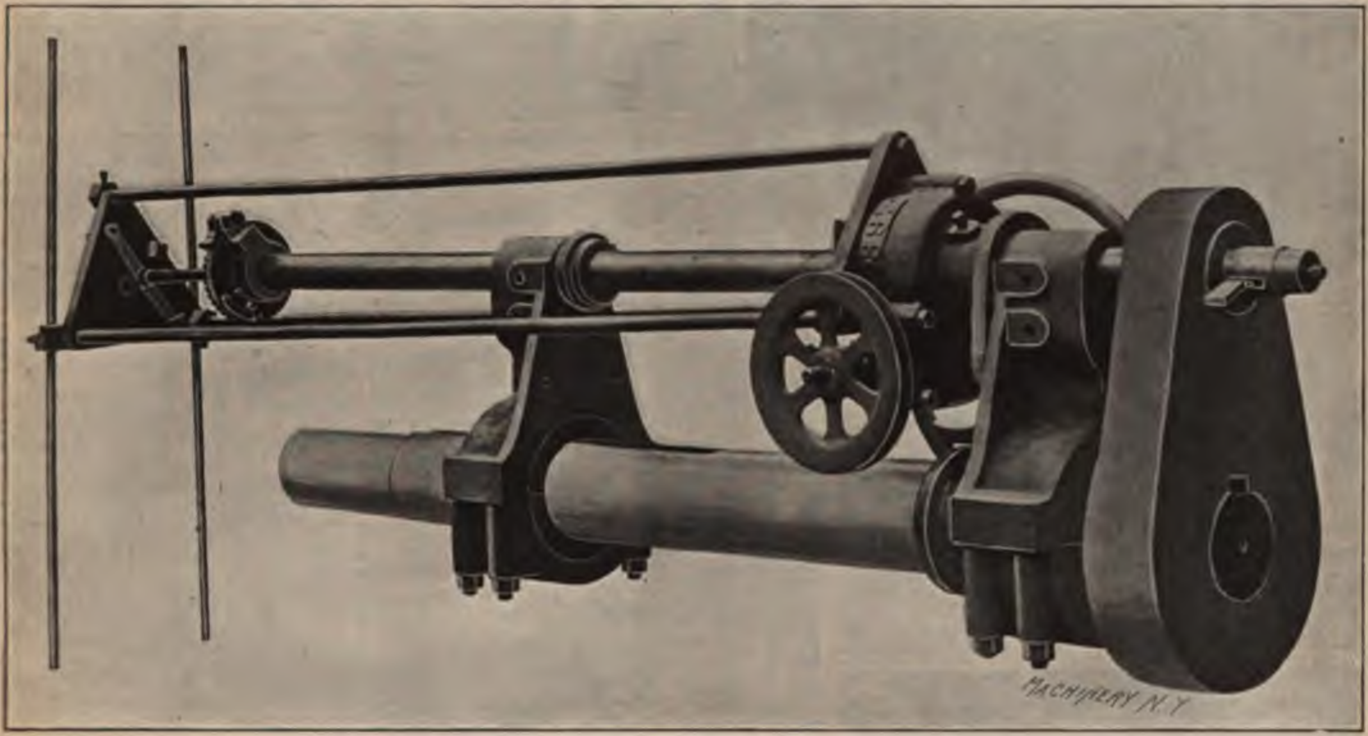
* * *

## FIXTURE FOR BORING ENGINE CRANKS.

The accompanying illustration is from a photograph taken for our use at the shops of the Lane & Bodley Co., engine builders, Cincinnati, Ohio. It shows a fixture built at these works for boring the crank-pin holes in their engine cranks. Many builders adopt the practice of facing the engine crank and then boring the holes for both the shaft and the crank pin after setting up the crank by this facing on the boring mill table or under the drill press. While this method will bring the two holes parallel and square with the facing, there can be no certainty that they will remain so after the crank has been pressed on the shaft. In fact, in the practice of Lane & Bodley, it has been found that the crank pin would frequently be out of line after the parts were together.

The device shown in the illustration is clamped to the shaft after the crank is in place and the hole is then bored for the pin and faced, insuring parallelism. The boring bar is supported by two arms clamped to the shaft. These arms are bored out large enough to accommodate bushings, which in turn are bored to fit the shaft, thus making the rig adapted to shafts of any diameter. A separate pair of arms is provided for engines of different stroke and the fixture thus serves not only to produce a true crank-pin hole, but also to bring the center distance between the crank and shaft correct. The bar is driven through a worm and worm wheel by a rope drive, as is plainly indicated. The feed is by a screw and nut operated by a ratchet at the back end of the bar. The screw bears against and is kept from turning by a triangular-shaped piece that is supported by three rods attached to the driving head of the machine, and by two rods resting on the floor. A ratchet wheel is threaded to fit the screw and is free to turn upon the latter; and when it turns, it pushes the bar ahead. The ratchet wheel is operated by a pawl which rotates with the bar and is allowed to drop into contact with the teeth of the wheel, or is raised from contact by a cam which is adjustable and can be set to give any desired feed within its range. This cam is kept from turning by a feather which slides in a spline in the feed screw.

Since adopting this fixture the Lane & Bodley Co. have had uniformly good results and have not had a crank pin come out of line. In this connection it may also be mentioned that they depend entirely upon the press fit to hold the crank pin in place. No nut is used on the pin nor is the pin riveted over at the back. As our readers probably know, there is in vogue at this shop the most complete system of inspecting and recording the sizes of the parts that are to be pressed together, probably in existence. It can be told exactly how many thousandths of an inch was allowed, or rather, actually left, by the workman for forcing, and also how much pressure was required for any part of any engine. With this certain knowledge, therefore, it is believed to be better to depend on no makeshift to hold the crank pin in place, when, if it is forced in sufficiently tight, the friction is ample to hold it securely. It is further believed that if a pin is not forced in properly, it is better to withdraw it and force in a larger one than to try to "make it go" by screwing on a nut at the back.



Machine for boring Cranks in use at the Lane & Bodley Shops, Cincinnati, O.

* * *

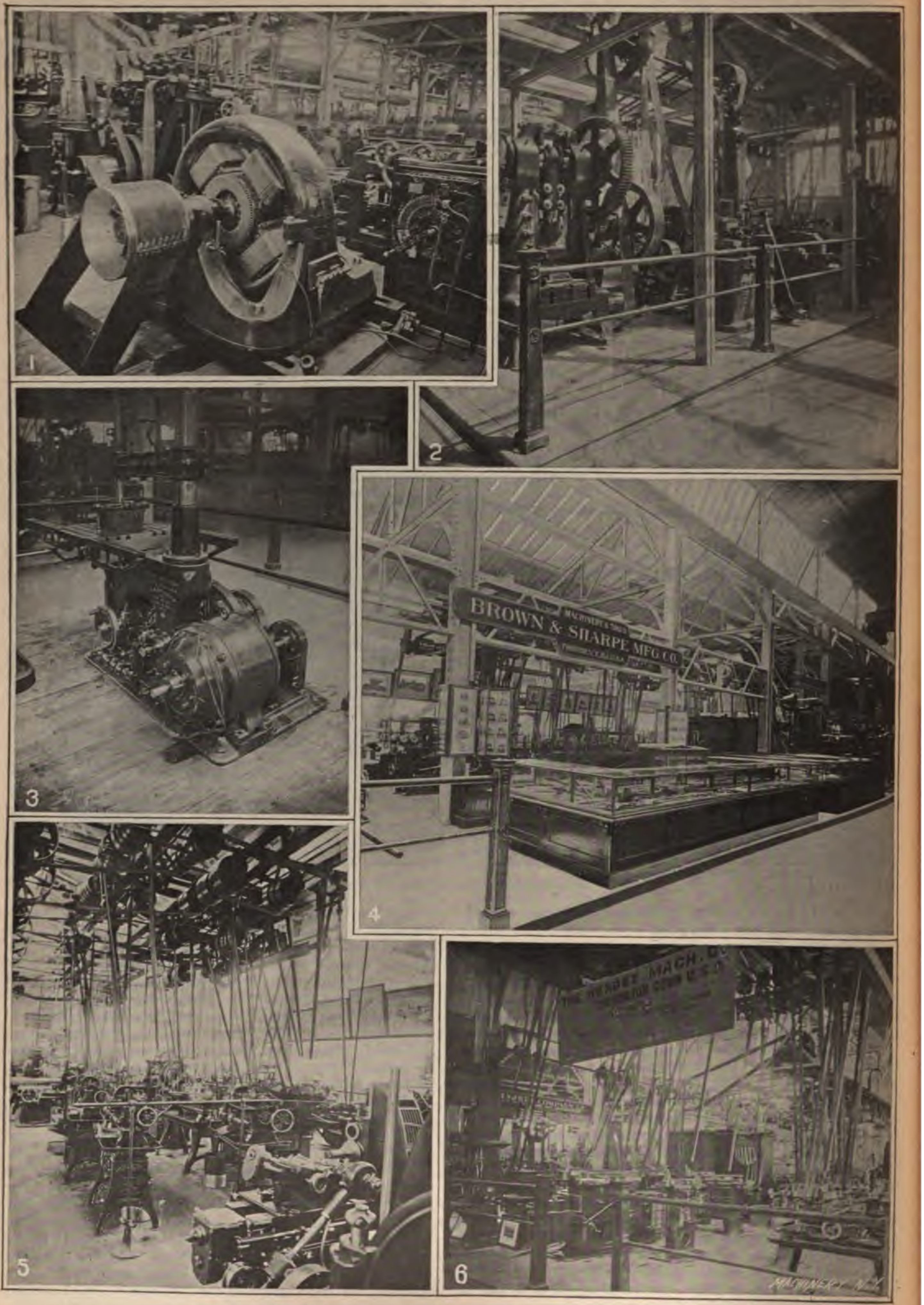
## LIQUID AIR.

In a recent number of the Sibley Journal of Engineering Dr. Robert H. Thurston discusses the possible sources of energy for automobiles. Of late liquid air has been urged as a source of power for this and other purposes, and Dr. Thurston expresses his views on the subject as follows:

"It stores comparatively little energy, is enormously costly, especially as a competitor with energy-storage fluids of little or no cost, requires very large quantities per horse power delivered, and no known way exists for its storage for any considerable or satisfactory period, without immense waste. According to Linde—perhaps its most successful, experienced and reliable producer—it requires a hundred horse power at the compressor to produce as many pounds per hour, and it can develop but a fraction, probably a small fraction, of that amount of power in regasifying. It loses by simple vaporization, even in large vessels, ten gallons and upward, about 4 per cent., under the most favorable conditions for its preservation, each hour. Its efficiency in the motor is found to be about 4 per cent.; that of the steam engine is from 7 to 20 and more, and that of the gas engine ranges to still higher figures. In the perfect heat engine the quantity of air required to do the same work within the same range of temperature of operation is about sixteen times as much as of steam; while steam costs nothing as a crude material and liquid air costs no one knows precisely what—probably not less than three or four times, perhaps ten or fifteen times, as much as the fuel used with the steam engine or the gas engine.

"The wild claims of the promoter of the stock companies now in the market for speculative purposes are probably based on but little better reason than those of Keeley or of other mountebanks. Taking its cost in the engine at the advertised minimum, about $8 per ton, and that of steam in the engine at about $0.00025 per lb., about 50 cents a ton, and $4 for coal, the relation is sixteen to one in favor of steam per pound, and many times this per horse power developed. A first-class steamship of 10,000 horse power would probably pay $100,000 for the air alone to operate the proposed system of machinery in a single voyage across the Atlantic. We are, however, still awaiting exact data, and the proposing investor in this field will meantime do well first to ascertain the exact character and records of the men with whom he must deal, their intellectual as well as moral reliability and their standing as scientific men as well as mechanics and mechanical engineers; next to secure by personal observation and measurements, or through a trustworthy and reputable expert in that specialty, precise figures of power expended, product secured and costs of power and product, and, finally, its availability as shown, not through prophecy but by actual experimental and life-size work, for the particular purpose in view. It is always perfectly practicable to ascertain just what the business side of the proposition may be expected to be worth through a careful and accurate investigation, by properly conducted experiments, by well known and reliable methods familiar to every member of the engineering profession.

"The best evidence that the writer has thus far collected indicates that the cost of even refrigeration, in ordinary cold-air work and transportation, as of fruits by train, must be several times as much with liquid air as with ice. The former, costing above sixty times as much as the latter, pound for pound, is capable of far less refrigerating effect per pound. In no ordinary work can liquid air compete with ice or the refrigerating machine.



GROUP OF AMERICAN EXHIBITS AT PARIS. (See opposite page.)

# THE VINCENNES EXHIBITS.

## HE AMERICAN MACHINE TOOLS APPEAR AT THE UNITED STATES MACHINERY BUILDING, PARIS EXPOSITION.

WARREN E. WEINSHEIMER.

ugh the United States Machinery Building at Vin-
was the only place ready to run on the 14th of April,
vas the formal opening of the Exposition, it was not
ay 10th that exhibits were sufficiently in place to open
lding to the public. Since the 14th of April, the boiler
ıporary engine plant have been in regular operation,
nade it possible to use the 30-ton Shaw crane to move
vy machinery. This crane has been of wonderful ser-
unloading and moving cars and also in installation, and
ntages over the French methods of doing this work by
rce are keenly appreciated by exhibitors and visitors.

ormal opening of the building took place on May 10th,
of the main entrance on the south facade. Mr. F. E.
director of the departments of machinery and electricity,
ned over the space to the Commissioner General. At
mony the United States guards in their regular uniform
esent. These guards are stationed in the various build-
d are supposed to see that nothing is stolen from exhi-
nd also to give information to visitors.

uts shown here illustrate some of the most interesting
in detail as they appeared June 12th. Let us begin in
order and, entering the main entrance, walk along the
ransverse aisle. Fig. 1 shows a line of wood-working
ry made by J. A. Fay & Egan, occupying Block XIV,
Hill, Clarke & Co. and the Springfield Machine Tool
ıpy the corner, Block XIII, Fig. 2, with multiple drilling
s and engine lathes, respectively. The Mossberg & Gran-
g. Co. have an exhibit of belt-driven drop hammer presses.
cupy Block XIII, space 6, and are also shown in Fig. 2.
ately across the aisle, space 4, is an interesting machine
r Bros. for cutting keyways in gears, pulleys, etc. It is
onnected and very compact, as will be seen by Fig. 3.

ave now arrived at Block I and find here a case of L. S.
's tools in space 1. Next to this is the Norton Emery
Co., occupying space 2 and showing a fine line of emery
and grinding machines. Space 3 is that of the Leland
oner Mfg. Co. with universal trimming machines. Space
all the styles of the grinding and polishing machinery
Builders' Iron Foundry. Space 1, Block II, is occupied
Gisholt Machine Co., and contains a large exhibit of
sized universal turret lathes. Space 2 is occupied by
ıchinery for pattern makers of the American Machinery
nwick Freres, one of the largest Paris agents of Amer-
chine tools, have spaces 3, 4 and 5 for the vertical drill-
hines of the W. F. & J. Barnes Co., while space 6 is an
of oils made by Fiske.

ace 1, Block III, the Prentiss Tool & Supply Co. show
nd multiple drilling machines and an engine lathe. Space
n & Sharpe's, is one of the largest and most attractive
here. Fig. 4 shows a front view, with the beautiful
milling cutters, scales, calipers, gages of all kinds. The
the rear, slightly taller than the flat ones, contains one
latest standard measuring machines. It has microscope
ent on one end and on the other a vernier, from which
may be taken to 1-10,000 of a millimeter. Some of the
of work done on the dividing engine machines on pol-
eel are marvels of accuracy and beauty. The lines are
closely together and the steel is so finely polished that
ld think it a mirror reflecting a spectrum from a prism.
hows the rear part of Brown & Sharpe's exhibit, where
e universal milling and grinding machines and automatic
rew machines, one of which in the foreground is turn-
ar buttons out of a solid piece of brass and milling
1900," on the back entirely automatically. This view
rly shows how the shafting is arranged. In space 3, ten
lathes of various sizes and two universal milling ma-
re exhibited by F. E. Reed. Fig. 6 shows three Hendey
nd shapers of their newest design located in space 4.
see the handle for changing the gearing off from the
ew to the lathe spindle in cutting threads, which is one
of the convenient attachments of the Hendey-Norton lathe. Their shapers are too well known to need further comment.

In Block IV, space 1, is occupied by Warner & Swasey, where they are exhibiting five turret lathes for automatic boring and tapping. Their two- and four-spindle milling machines for milling the hexagonal ends of globe and angle valves at the same time are interesting, as is also a novel grinding machine for fitting and grinding plugs in cocks.

Space 2 contains Pratt & Whitney's exhibit. Fig. 7 shows the front and Fig. 8 the back of the exhibit, shafting, belting, pulleys, etc. Their line is quite similar to Brown & Sharpe's, and shows in front two interesting cases of small tools, and on the side and rear the larger machines, such as toolmakers' lathes, centering machines, cup and cone-cutter grinding machines, machines for gun drilling and rifling, hand turret head screw machines, automatic head screw machines, magazine attachments, etc. Spaces 3 and 4 are occupied by the Bullard Machine Tool Co., who have on exhibition three large boring and turning mills and three large turret lathes.

In Block V the Ingersoll-Sergeant Co. have, besides a Corliss engine air compressor, a number of their tripod rock drills, one traveling steam drill and a simple engine air compressor. The H. B. Smith Machine Co. devote Block VI to large wood-working machinery, five planers, two circular saws, and one band saw. In Block VII, spaces 1 and 6, is the exhibit of Simonds Mfg. Co. Space 2 is the office of the director; space 3 contains an interesting direct-connected milling planer manufactured by the Ingersoll Milling Machine Co., and shown in Fig. 9. In space 4, the Acme Machinery Co. exhibit their automatic bolt headers.

Space 1, in Block VIII, is devoted to the exhibits of the Standard Pneumatic Tool Co.; 2, to the Becker-Brainard Milling Machine Co.'s vertical milling machines; 3 is occupied by Flather &Co.; 4, by the Cincinnati Milling Machine Co.; and 5, by the Ferracute Machine Co.

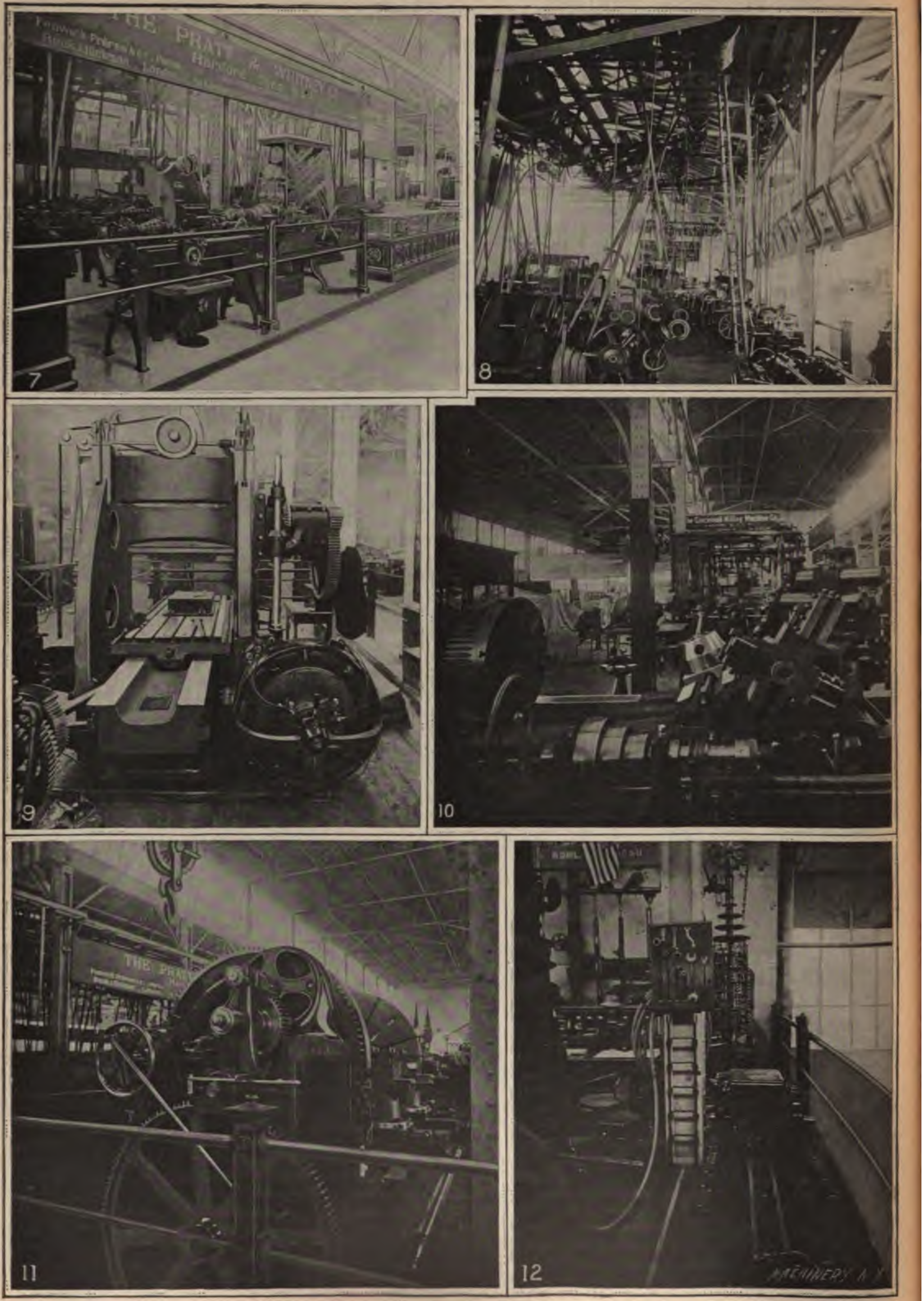
Block IX, space 2, is occupied by the Chicago Pneumatic Tool Co. and by Markt & Co., who represent a number of firms. Among the exhibits here installed are a Mietz & Weiss gas engine direct-connected to a Lundell dynamo; Osterlein Machine Co.'s universal milling machine, and Grant Tool Works' vertical drilling machine. Fig. 10 is a view of the turret on the large Conradson lathe. Space 3 is occupied by Adolph Janssens, with a collective exhibit; Potter & Johnston Co. have one milling machine; Perry Ransom, a double grinding machine; the Westcott Chuck Co., a pyramid of chucks which can be partially seen in Fig. 10. Space 4, the American Tool & Machine Co., and 5, the Landis Tool Co.

The Niles-Bement-Pond Co. occupy the whole of Block X with very large machinery. There is a large boring machine, engine lathe and planer belonging to Pond. The Niles Co. show two large vertical boring machines, two large lathes for turning locomotive driving wheels. The larger of these is shown in Fig. 11. Fig. 12 shows a coal mining machine exhibited by the Jeffrey Mfg. Co., in space 2, Block XI. Space 1, Block XI, is occupied by the Rand Drill Co., with a Corliss engine air compressor and six drills.

Space 1, Block XII, contains the exhibits of pneumatic tools, saw-cutters for metal, riveting punches, engine lathes, turret lathes and milling machines of the Q. & C. Co. Gould & Eberhardt have a gear-cutting machine for spur gears in space 2. In space 3 are the milling machines of R. K. LeBlond. The Vacuum Oil Co. have their exhibit in space 4, and spaces 5 and 6 are occupied by the Fellows Gear Shaper Co. and the Jones & Lamson Machine Co., with the Fellows gear shaper and machine screw turret lathes, respectively.

In Block XIV, spaces 1, 5, and 6, Sussfeld Lorsch & Co., Paris agents, show the Morgan Machine Co.'s box making and nailing machines, and a full line of saws and saw-sharpening and saw-making machinery made by Baldwin, Tuthill & Bolton. Space 2 contains five large stamping machines built by the E. W. Bliss Co., and in space 3 is an exhibit of De Fries & Co., Paris agents.

As will be noticed, the distribution of the machinery has been made to give the effect of being an ordinary machine shop on a large and varied scale. The exhibitors, no doubt, feel repaid for their efforts, as this building is the most interesting exhibit of the Exposition in this group.



GROUP OF AMERICAN EXHIBITS AT PARIS. (See preceding page.)

# MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—10.

## PLANING MACHINES.

W. H. Van Dervoort.

The planer and shaper, with their modifications the slotting machine and key-seater, constitute a distinct class of machine tools, the office of which is to machine plane and irregular surfaces that can be most readily machined by a straight-line cut. Although a considerable amount of work that, until a few years ago, was classed as planer and shaper work has been turned over to the milling machine, there still remains a very wide range of work that must continue as planer and shaper work. These tools bear to the machining of plane surfaces practically the same relationship that the lathe does to the machining of round work. The cutting tools used on the planer and shaper are practically the same as those used on the lathe, and the general principles involved in the operating of the machines are quite similar.

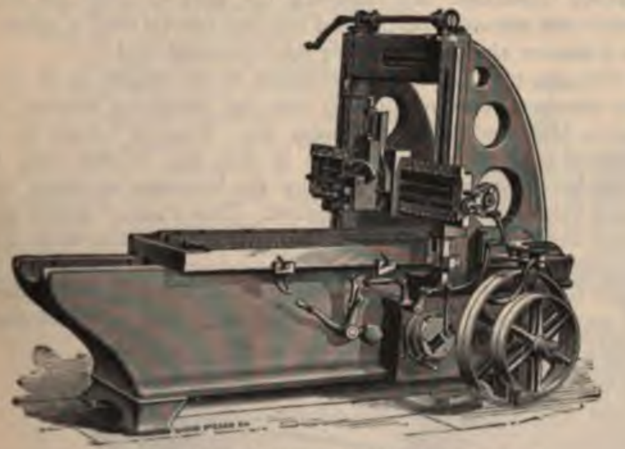


Fig. 87. G. A. Gray Planer, Illustrating Modern Type.

The planer and shaper, although used on the same class of work, differ materially in design. In the planer the work moves to the tool, while with the shaper the tool moves over the work. In the planer the vertical and lateral feeds are given to the tool, while on the shaper the lateral feed is usually given to the work, the vertical feed, however, being given to the tool. In what is known as the traverse head shaper, both feeds are given to the tool and the work is held perfectly stationary.

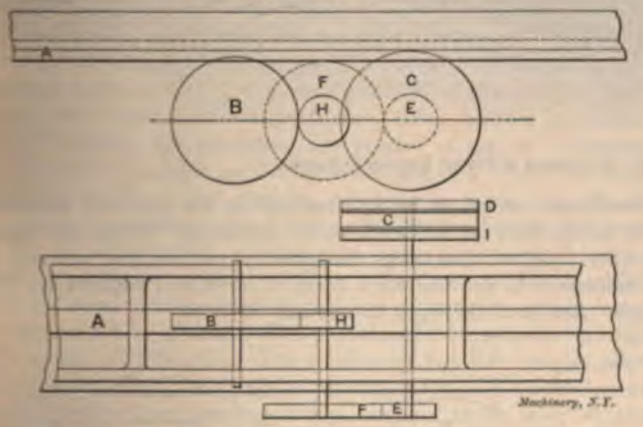


Fig. 88. Table Driving Mechanism.

In Fig. 87 is shown a standard modern planer. The bed is deep and heavy with the work table moving in inverted vees. The housings or uprights are secured firmly to the bed and cross-tied at the top. The cross rail is gibbed to the front of the housings and carries the tool head. The cross rail is adjustable vertically, being operated by the two elevating screws by hand on the smaller machines and by power on the larger ones, as shown in the figure. On the large machines, two heads are frequently used on the cross rail and one on the face of each housing, thus enabling several cuts to be taken on the work at the same time.

The important features of the planer are its table driving mechanism including reversing gear and the mechanism for operating the feeds. In some of the earlier planers the table was driven by a quick-pitch screw with suitable gears and pulleys at the end of the bed. This method has been entirely replaced by the rack and gear drive and the Sellers or spiral gear drive. In Fig. 88 is shown the gear arrangement as commonly used in the rack and gear drive. The rack A is secured to the bottom of the table. The gear B meshes with the rack and is driven from the pulley C through the gear reductions E F and B H. D and I are loose pulleys carrying belts that run in opposite directions. When the belt running in the direction of the arrow is on the pulley C, the table and work move toward the tool and when the reverse belt is thrown upon C, the table moves the work away from the tool. The backing belt is usually driven at about four times the velocity of the forward belt, thus giving the table what is termed a quick-return motion. The object of this is to get the table and work back and ready for another cut with the least possible loss of time. As applied to the planers by different makers, this mechanism differs somewhat in its arrangement, but in all cases is a simple geared reduction. The reversing mechanism differs materially on the various machines. That used by the Gray Co., on the planer shown in Fig. 87, illustrates one of the simpler methods. As quite clearly shown, the belt-shifting rings are attached to a pair of arms controlled by cams. The dogs, which clamp to the side of the table at any point in its length, engage the shipper lever on forward and return strokes, through the connecting rod, and move the cam plate and belt arms. The motion is such as to cause the belt driving to be shifted from the tight pulley before the other belt is shifted on, thus preventing both belts from getting on to the tight pulley at the same time. As these belts must be shifted very quickly and, when the table is making short strokes, very often, it is quite necessary that the belts be narrow and run at a high velocity. These belts will not shift properly if run too tight, and should always be of the best grade of double leather belting in order to stand the wear and pressure on the edge. As it is frequently necessary to run the work out from under the tool to make measurements and it is not desirable to change the position of the dogs, the shipper lever is provided with a trip stop which can be raised, to allow the dog to pass over without changing its position. The planer cannot be depended upon to stop its table at exactly the same place each stroke. This variation may arise from changes in the pressure of the cut, but more frequently from changes in the speed of the belts, thus varying the time in which the inertia of the rotating parts is overcome each time the belt is shifted.

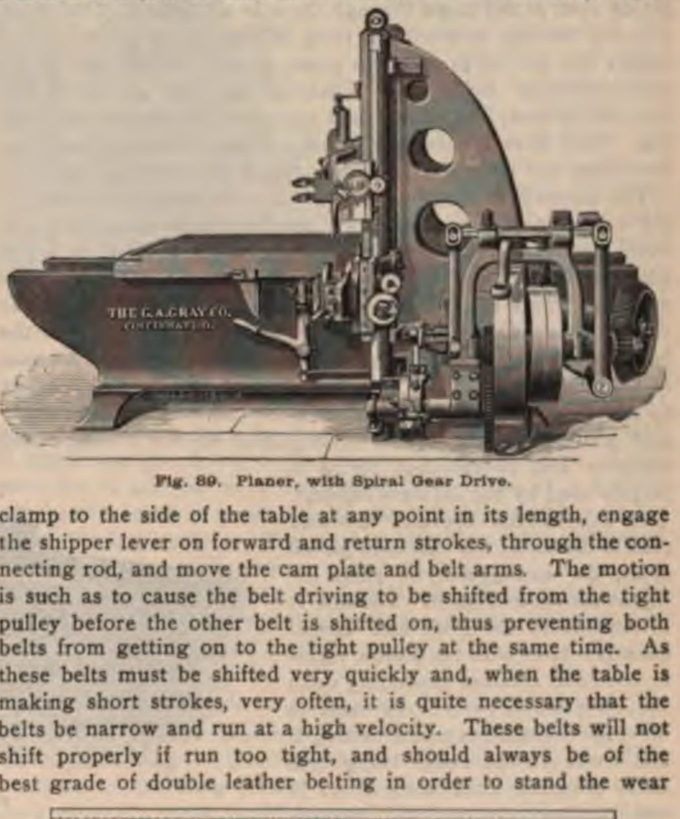

THE G.A.GRAY CO.
CINCINNATI, O.

Fig. 89. Planer, with Spiral Gear Drive.

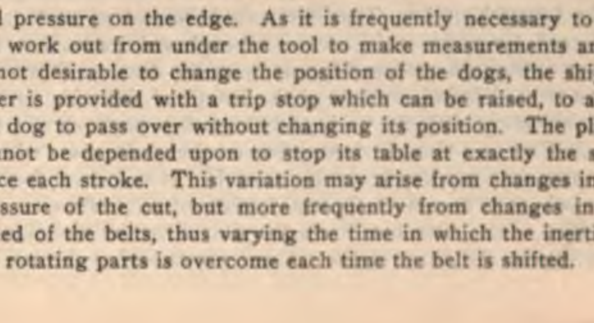


Fig. 90. Spiral Gear Mechanism.

In Fig. 89 is illustrated a planer with a spiral-geared or Seller's drive, and the planer shown in Fig. 94 also has a drive of this description.

As shown in Fig. 90, the mechanism for driving the table is quite simple. A spiral pinion, usually having a quadruple thread, engages a rack the teeth of which are at right angles to the length of the table. This throws the axis of rotation of the pinion away from the line of motion of the table an amount equal to the spiral angle of the teeth in the pinion and carries the pinion shaft at this angle through the side of the bed. This gives a broad bearing between the teeth of the pinion and rack and causes the line of pressure to come directly in the line of the table's motion. Suitable bevel gearing and tight and loose pulleys on the outer end of the shaft completes the driving mechanism. This drive is noted for its smoothness of action, and freeness from the vibration frequently found in spur gear drives.

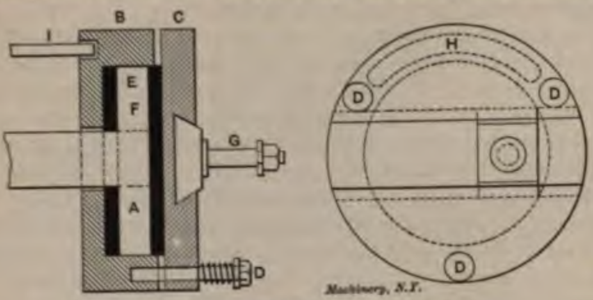


Fig. 91. Friction Feed Mechanism.

The mechanism for operating the feeds is comparatively simple on most planers, the same mechanism usually operating both vertical and cross feeds on the cross rail head, or heads when more than one are used. As the amount of feed adjustment per stroke must be constant and as the length of the stroke varies, it is necessary that the feed-operating device give the full amount of feed adjustment during a relatively small amount of the table's stroke. In fact, the shortest stroke it is possible to have the table make, should give the full feed adjustment for each stroke. In Fig. 87 the arrangement shown is simple and effective and in modified forms is largely used by the different builders. The head which operates the feed rack is driven by the extended pinion shaft, the arrangement of parts being as shown in Fig. 91. The disc A is secured to the shaft and consequently rotates with the pinion, right- or left-hand rotation depending upon the direction in which the table is moving. The disc carries a casting B and cover C, the cover being held to B with the three studs D D D and against the friction washers E and F with a uniform pressure by the spiral springs under the nuts on the studs. If the casing is relieved, it and the cover C, together with the wrist pin G, rotate until the casing is again held. In the back of the casing is a slot H into which the stationary pin I extends. The length of this slot is determined by the amount of casing rotation required. In action, the table starts on its stroke, B and G rotate until I strikes the end of the slot H and the rack has been moved up or down, depending upon which side of the center the pin G is on. As the table continues its stroke, the disc A slips between the washers E and F, and G remains stationary. When the table starts on its return stroke, A rotates in the opposite direction, carrying with it B and G until the pin strikes the other end of the slot, the rack having received motion in the opposite direction to that given on the forward stroke. Thus the rack is moved up and down once each time the table moves forward and back, and the amount of the rack motion depends upon the distance G is from the center and is independent of the length of the table stroke. A pinion gears with the rack and through a shaft carries the gear A, Fig. 92. Gear B rotates free on the shaft, gears with C and on its face carries the double pawl D. If the lower foot of this pawl, as it stands in the cut, is thrown in, it slips on the up stroke of the rack, but drives the gear B in the direction of the arrow on the down stroke. If the upper foot is thrown in, it slips on the down stroke and carries gear B in the opposite direction, the direction of feed being reversed. It is evident that with the wrist pin G, Fig. 91, on the same side of the center, the feed occurs at the beginning of the forward stroke when the feed is in one direction and reversal of the feed makes it occur at the beginning of the return stroke. The wear on the feed mechanism is least when the feed occurs at the beginning of the return stroke, as it is not then necessary to move the tool while cutting. On the other hand, feeding on the return stroke makes the wear on the tool in dragging back somewhat greater. When side heads are attached to the face of the housings, they are given a vertical feed on the housing in a manner similar to that already described. By removing the gear C from the cross screw and putting it on the feed rod, the vertical feed is operated in a manner similar to that for the horizontal feed.

The size of a planer is determined by the length of its table, the distance between housings and the maximum distance between table and bottom of cross rail. What is known as the extension side planer is shown in Fig. 93. In this tool, the capacity is increased by spreading the housings, an extra long cross rail, of course, being required. This class of planer is of value in shops where only a small per cent. of the work done requires a wide planer. Another modification known as the open-side planer is shown in Fig. 94. In this tool one housing is dispensed with entirely. The cross rail being heavy, strongly braced and carried on heavy housings on the one side, removes the width limit on the work to be machined. When the work is very wide and overhangs the table by an excessive amount, it is necessary to provide some form of out-board support for the outer portion of the work to rest on.

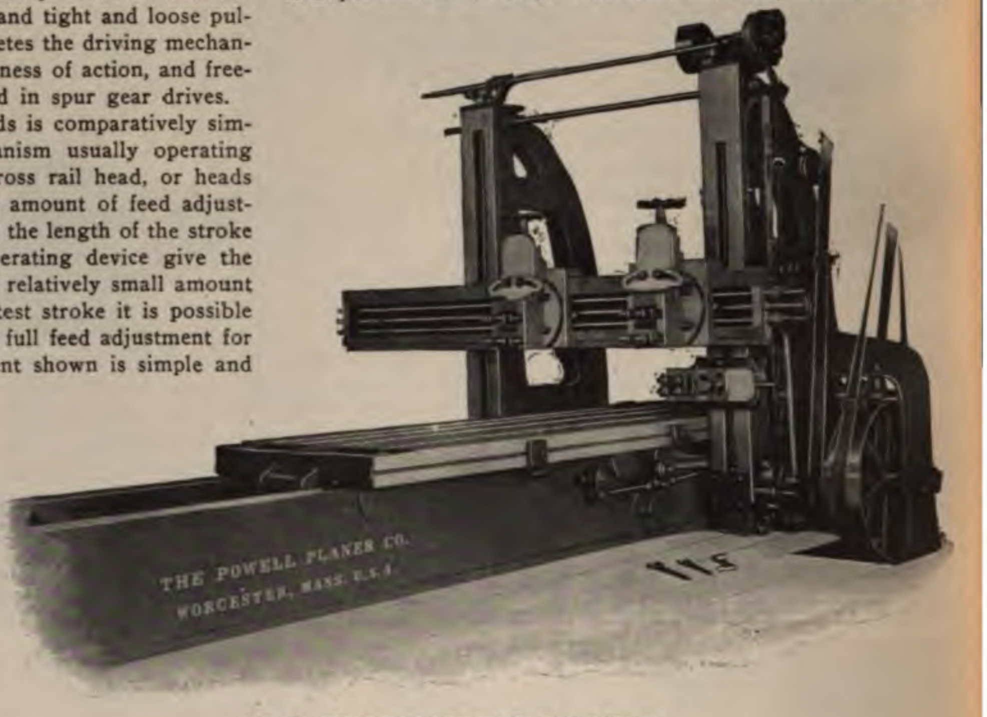


Fig. 93. Woodward & Powell Extension Planer.

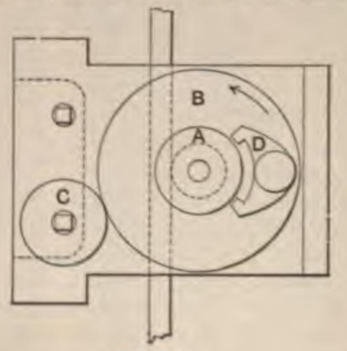


Fig. 92.

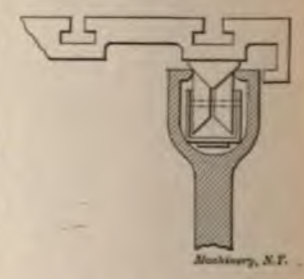


Fig. 95.

On all planers the cross rail is elevated by two square-thread screws set in the face of the housings and geared together at the top. These screws are preferably right- and left-handed and must be very accurately cut, as otherwise the cross rail will not remain parallel to the table in its width at all positions. On the sizes where the cross rails usually carry two heads and are ıeavy, the elevating screws are operated by power belted the countershaft.

form of bed shown in Fig. 87 is the one known as the box bed and is now quite generally used. It is strongly and its form is such as to make it very strong and rigid. orm of table guide quite exclusively used on planers is as the inverted "V." In any planer it is very important that guides be most carefully fitted and suitable means provided eir lubrication. The bearing surfaces are usually grooved in and distribute the oil with suitable wipers provided to the lubricant to these surfaces. In 5 is shown a common and very efficient method. An oil well or pocket is in the bed near the center of the motion and a pair of conical rollers d in a suitable frame and held against rface by a spring, carries the oil from ell to the surface to be lubricated. rincipal difficulty with this arrangement comes when the table is worked on stroke for a considerable length of as in that case the portion over the only is properly lubricated. On long strokes, however, tion is perfect.

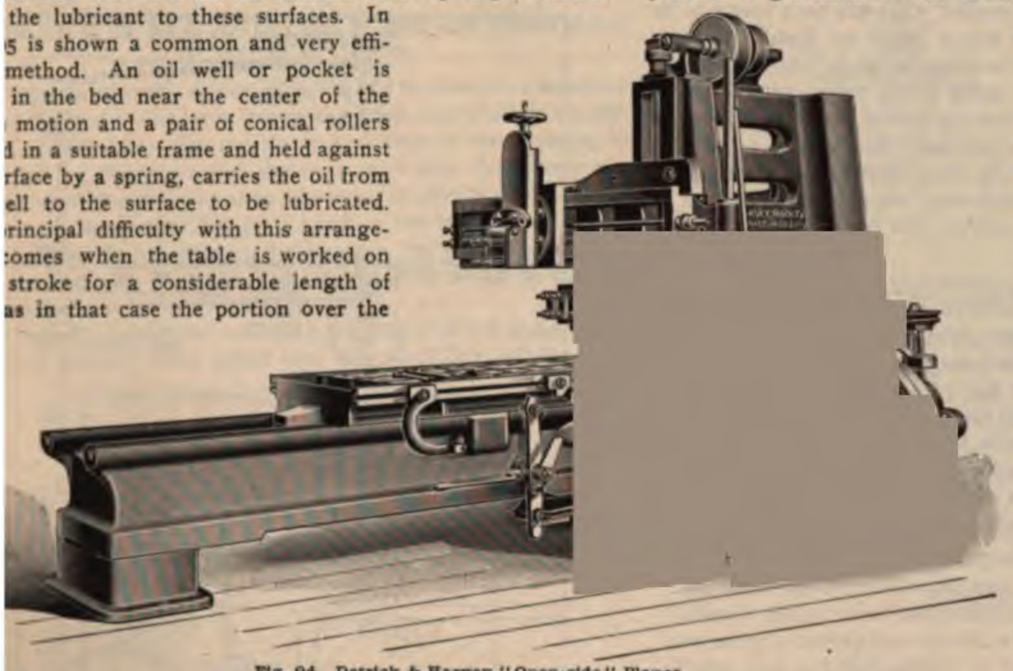


Fig. 94. Detrick & Harvey "Open-side" Planer.

planer table is always provided with a large number of for stops and for bolting the work to the table, also with e T-slots. These holes should be drilled and reamed and slots planed or milled in order that the bolt heads may freely in them.

* * *

## AN ACCURATE MACHINE.

dividing engine that was designed and built by Warner & y, Cleveland, Ohio, for use in connection with their astroal work is one of the most accurate instruments of preever made. It will graduate a circle with a maximum probably not exceeding one second of arc, or a distance third of an inch on the circumference of a circle two miles meter. It is not desired, however, to state that this is y the maximum error; this point will be determined later S. Government experts who have astronomical instru- graduated on this machine. The base of the machine n three rubber plugs upon a bed of masonry, which latter t on a bed of sand. This combination foundation success- esists all vibration. The work table is a flat circular plate is supported by a vertical taper spindle. This spindle was l to fit a taper bearing in the base, but as the table weighs l hundred pounds, it was necessary to relieve the friction bearing and the method employed to do this, as well as to the alignment of the table is simple and might easily have applications. At the lower end of the spindle is a ball bearing, which is pressed against the end of the spindle ights. The thrust of this bearing is about ten pounds less he downward thrust of the spindle, due to the weight of the and the spindle is therefore seated in its bearing with a re of ten pounds. Thus, supposing the table to weigh 500 s, 490 pounds of this weight would be carried by the balls e remaining ten by the taper bearing. This, it is calculated, icient to keep the table accurately in place and yet it turns ase.

table is spaced by the usual tangent screw or worm, which s in teeth milled in the periphery of the table. Contrary al custom, however, these teeth were not first milled and then corrected by a series of approximations. In the first place spaces were ruled upon an annular surface or ring of silver around the edge of the table. By careful microscopic measurements the variation or error from mark to mark was determined and another set of marks was ruled in which the errors of the first set were allowed for. These rulings were then measured and another circle graduated, and so on. Finally, when thought to be sufficiently accurate, the teeth were milled in the periphery of the disc for the worm or tangent screw.

The milling of these teeth was scarcely less difficult than the process of graduation. The usual process of rotating the hob and disc together could not be employed, of course, because there was no accurate means of feeding the disc. The latter must be moved by the aid of the final graduated circle, the distances being determined by microscopes, and it would thus be impossible to move it continuously. The only way was to move it a distance equal to the pitch after each tooth was completed, and to give the hob both a longitudinal and rotary motion as though it were a screw traveling along the edge of the disc. This produces the same relative effect as though the hob rotated, merely, and the wheel turned as though driven by it.

The blank for the hob is a tool-set steel screw lapped until practically perfect by the process used by Prof. Rowland in producing the screw of his famous dividing engine. Teeth were cut in one end of the screw, making a hob of it, and the other end worked in a nut and fed the hob longitudinally as the screw and hob rotated. The lapping was done after hardening to eliminate shrinking errors.

We trust that at some future time Messrs. Warner & Swasey will favor the mechanical public with a complete description of this extremely interesting machine.

* * *

An interesting feature of the immense foundry connected with the General Electric Works at Schenectady, are the portable jib cranes for serving the moulding floor. The foundry is served by a number of traveling cranes, but for a great deal of the local work in such a large establishment it is cheaper and more convenient to handle much of the smaller work by jib cranes. To facilitate the use of these cranes and yet prevent such a multiplicity of them as to interfere with the open space, the frames of the jib cranes are arranged with hinges similar to that of an ordinary gate. Similar hinges are provided on the supporting posts throughout the length of the main aisle, and whenever a jib crane is wanted at any particular spot, it is transported to it by the traveling crane and hooked in place. Thus a small number of the jib cranes are made to cover the entire area of the foundry floor and are made instantly available wherever needed.

* * *

By the introduction of a form of induction coil in a submarine cable at certain distances apart, Prof. Pupin, of Columbia University, has demonstrated that long-distance submarine telephony may soon be a commercial possibility. With an experimental cable line 250 miles long operating under practically the same conditions as exist with a submerged cable, conversation was distinctly audible, a fact that is of considerable importance when it is known that 40 miles of cable is the limit of submarine telephony at present. The discovery it is thought will not only increase the range of submarine telephony, but also greatly augment the commercial radius of aerial lines. Submarine telegraphy can also be facilitated by its use, as then it will probably be possible to use the quadruplex system and thereby increase the capacity of the cable four times.

# NOTES ON THE TRANSMISSION OF POWER.

## STEP BEARINGS, VERTICAL SHAFTS AND COUPLINGS.

An article appeared in the July, 1899, issue of MACHINERY on "Step Bearings" in which were shown a number of forms of this somewhat unsatisfactory form of bearing which had given various degrees of success. The proper construction of a step bearing is an important feature in machine design and the failure to observe proper precautions in its design and construction has often been the cause of considerable trouble. The trouble with the step bearing is to obtain sufficient area for the pressure so that the load per unit of area will not exceed what has been found to be safe practice. If the load per unit is found too high, it is often of no avail to simply enlarge the diameter of the bearing surface, as by so doing the peripheral speed of the outer portions of the bearing is so much increased that the saving in pressure per unit is more than made up by the increased friction due to greater velocity. Again the wear on the outer portions is greater than near the center, so that a simple step bearing quickly wears to have a bearing only near the center, with the result that heating ensues.

The writer recently had an opportunity to examine a form of thrust or step bearing manufactured by P. Pryibil, New York, which is said to give excellent results. This bearing is made specially for supporting vertical shafts in establishments where power is to be transmitted to upper floors and it is desirable to avoid cutting belt holes through the floors. The advantages of this method of power of transmission to upper floors are worth consideration. The loss from friction is said to be considerably less than where the ordinary belts are used for the purpose and not least, the fire risk is greatly reduced, as belt openings are not required with the vertical shaft.

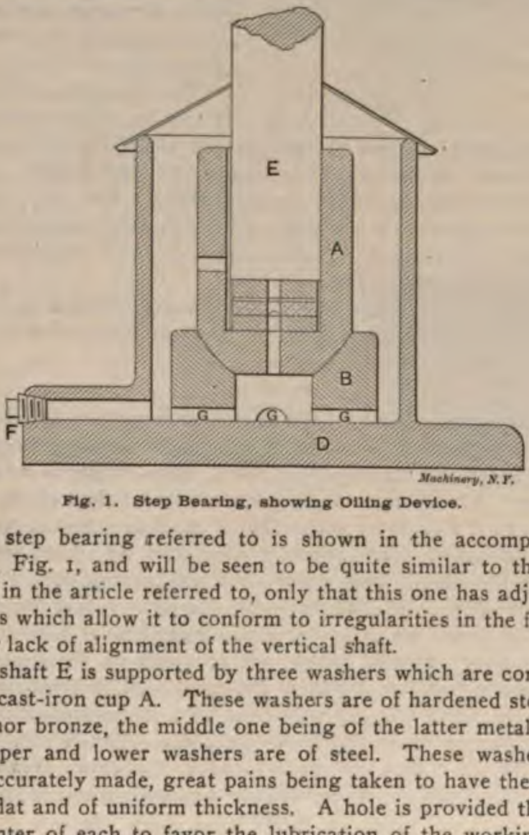


Fig. 1. Step Bearing, showing Oiling Device.

The step bearing referred to is shown in the accompanying sketch, Fig. 1, and will be seen to be quite similar to the ones shown in the article referred to, only that this one has adjustable features which allow it to conform to irregularities in the foundation or lack of alignment of the vertical shaft.

The shaft E is supported by three washers which are contained in the cast-iron cup A. These washers are of hardened steel and phosphor bronze, the middle one being of the latter metal, while the upper and lower washers are of steel. These washers are very accurately made, great pains being taken to have them perfectly flat and of uniform thickness. A hole is provided through the center of each to favor the lubrication of the working surfaces. The cup A has a spherical surface at its lower end which fits in the casting B. The latter being accurately bored to fit the rounded end of A, supports the cup with the shaft, but allows it to take any position within limits necessary for perfect alignment. To allow for variation from exact position, the part B is not secured to the outer shell D, but sets loosely on the bottom and can therefore slide into the correct position. The parts A and B, being of larger diameter than the bearing, do not rotate, as they have much greater frictional resistance. The outer part being filled with oil, the bearing is constantly flooded and the centrifugal action tends to create a circulation through the holes G G G up through the central hole in the washers and out through between their faces. The multiplicity of bearing faces prevents cutting as, when friction between any two opposing faces becomes so great that abrasion begins, the motion between them ceases and takes place between some of the others.

An instance is quoted where this form of bearing is in successful operation in a Connecticut factory in which the vertical height of the shaft is 100 feet with a diameter of the lower section of about 4" and is run at a speed of 160 turns per minute. The total weight on the step due to the shaft, couplings, pulleys and belts is about 4,800 pounds or 380 pounds per square inch of bearing surface. The approved form of belting to the horizontal shafts on the different floors is that shown in Fig. 2. The belts from the pulleys on the vertical shaft B are carried over a mule pulley or idler C C C. By using the idler or guide pulley, as shown, the usual difficulties with quarter turn belts are avoided. The belt wears longer, as it is not so severely strained along one edge, and it does not run off if the line shaft be turned backwards; and the idler presents an effective means of taking up the slack in the belt, thus making frequent cutting and lacing unnecessary. Of course, in such an installation, the pulleys should be so arranged as to put the idler on the slack side of the belt, as in this position it is more effective and the loss by friction is far less than when oppositely placed. A feature of this form of power transmission, which will often be of value, is that power can be transmitted to shafts running at right angles, without complication. If done on the same floor, one pulley will be located high enough to clear the belts from the other, but otherwise the belting will be the same for each.

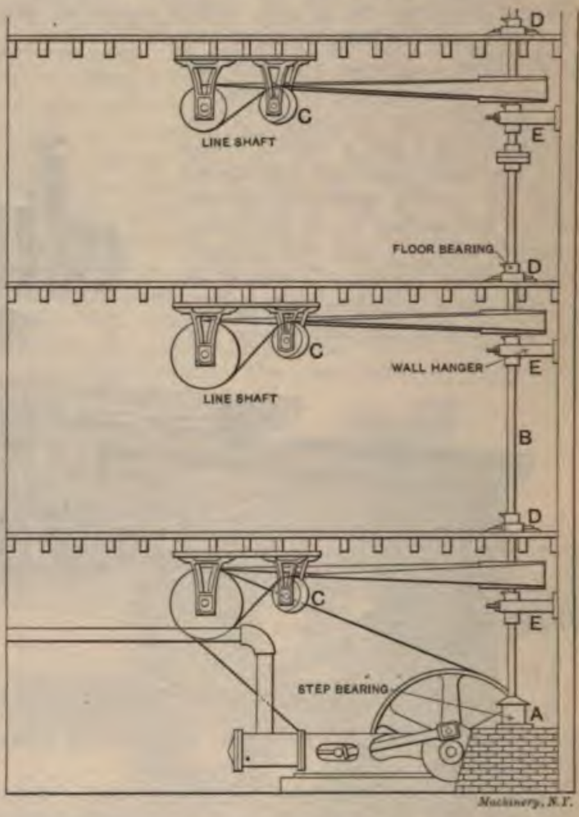


Fig. 2. Transmitting Power by Means of a Vertical Shaft.

A form of clamp coupling developed by the same manufacturer is that illustrated in Fig. 3. The coupling has an internal part A and is connected to the rim only on one side. The part A is split on the side opposite to its connection with the exterior and is also

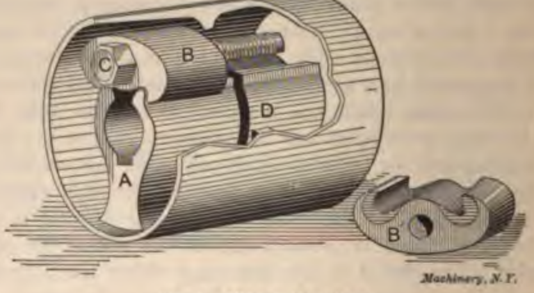


Fig. 3. Clamp Coupling.

cut in two laterally on one side, as shown at D. The other side is continuous throughout its length. The clamps B B' are dovetailed to fit over the free end of A and are tapered, as are also the edges of A. As the tapered parts of A are opposed, when the two clamps are drawn together by the bolt C, the parts of A are firmly gripped on the shaft. The side of the coupling that is continuous preserves the alignment. This clamp requires keys and keyways the same as the ordinary flange, but has the advantage of being easier to connect or remove and can also be used on shafts having slightly different diameters without necessitating special fitting.

* * *

## TODRANK TIOSA AND THE BOSS, OR THE MAN OF FEW WORDS.

Todrank Tiosa was a man who worked in a country machine shop, and lived on his farm, which he owned, and which his father owned before him. He got up at 4 o'clock in the morning to look out for things around the farm, and then drove into the village where the machine shop was situated, and of course drove back to the farm after his day's work in the machine shop was done. This was all right in the summer, but rather a hard job in the winter, but Todrank never complained, being "a man of few words."

Birdseye Birmingham, who was the owner of the shop where Todrank worked, often asked him why he didn't sell his farm and move into the village, and held up in glowing terms the advantages which Todrank would reap by such a move. The long, cold drive in the winter would be no more; getting up at 4 o'clock in the morning would be a thing of the past; and, if there happened to be a circus in town, Todrank could go and get home in time to go to bed before starting to work, and when finally

GORMAN'S
EQUINE MARVELS
Moving in
MAJESTIC MARCH
MANOEUVRE
DANCE
and
TABLEAUX
Building Pictures
of
ENTRANCING SPLENDOR
in
SIMULTANEOUS ACCORD

was announced on the bills, it was the last straw which induced Todrank Tiosa to take Birdseye Birmingham's advice, sell his farm, and move into the village.

"It was the last straw which induced Todrank Tiosa to . . . . . move into the village."

The farm was a large and valuable one, and Todrank sold it for enough to have a little cash balance left over when he got his house in the village paid for, and he said "nothing to nobody," but went with his cash balance and bought a wood lot.

"But Todrank 'never said a word.'"

Not long after Todrank got settled in the village, Birdseye came around one day and told Todrank that business had not been very good lately, and that it became necessary to reduce Todrank's wages to the extent of about 15 per cent., but Todrank "never said a word" much to Birdseye's surprise.

When Todrank went home from the machine shop that night he stopped on the way and bought an axe.

The next morning he took the axe and started for his wood lot and began to cut wood, still saying nothing.

Birdseye missed Todrank, and was a little surprised, because Todrank was a remarkably steady man, and he kept on missing him every morning for a week, when his curiosity got the better of him, and he called around to see Todrank in the evening.

Todrank was at home and seemed glad to see him, but hadn't much to say as usual.

Finally, Birdseye had to speak right out and ask Todrank where he had been the last week.

"Oh, over in my wood lot," said Todrank.

"Why," said Birdseye, "I didn't know you had a wood lot."

"I did," said Todrank, from which it will be seen that Todrank was a man of few works, as mentioned above.

"Well," said Birdseye, "what I called to say is, that business has improved very much during the last week, and if you will come right back to work, we can manage somehow to pay you the same we have been paying."

"He took his axe and started for the wood lot."

And there have been no more trees cut down on the wood lot since.

It is too bad to cut down all the trees, anyhow.

Greasy Jay.

* * *

While failures are always discouraging, there is the consoling feature about them that they always convey a greater lesson and are thus in some respects a greater friend to mankind than are the successes of life. A boiler may stand a test of 250 pounds under hydraulic pressure and be called a success, while the same boiler may explode under 175 pounds steam pressure and be called a failure. In the one case the boiler was called safe, while in reality it was a menace to public safety. In the other it was shown to be unsafe and while the explosion might have been disastrous, it probably taught the lesson in design that was needed and, before constructing future boilers from the same drawings, changes could be made that would make a repetition of the explosion impossible.

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MACHINERY

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## AUGUST, 1900.

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| 1899. | | 1900. | | 1900. | |
|---|---|---|---|---|---|
| September... | 18,000 | January..... | 20,000 | May......... | 21,500 |
| October...... | 17,500 | February... | 20,500 | June........ | 27,500 |
| November... | 17,750 | March....... | 25,000 | July......... | 22,000 |
| December... | 18,500 | April........ | 21,500 | August...... | 21,500 |

This number of MACHINERY completes the sixth volume. The index for the year will be ready about September first, and will be mailed to all who send a request for it.

* * *

Prof. Jacobus, in describing the system of instruction at Stevens Institute, recently said: "For every principle given in the class room the students are required to either make or witness an experiment to verify the same. What a student does with his hands in connection with his head he remembers much better than any knowledge he may obtain from the text books or lectures alone."

A reversal of this statement might be made that would be applicable to every young mechanic who aspires to better things for the future. Such mechanics have plenty to do with their hands. The simple doing of these things over and over in a mechanical sort of way may enable them to turn out more pieces in a day and to make the pieces better. Both of these results are to be desired, because the more work a man can do, and do well, the more money he is worth; but it is also true that the more kinds of work he can do, and do intelligently, the more money he is worth, and the only way to accomplish this result is to work with both mind and hand.

* * *

## USELESS AND USEFUL ATTACHMENTS ON MACHINE TOOLS.

The writer recently visited a well-known Government works, and in one of the shops devoted to light work noticed a large number of engine lathes of from 14" to 20" normal swing, which were all provided with the gap arrangement, so that their capacities could be considerably increased for face-plate work.

While it is not denied that a gap lathe is a useful tool for some shops, especially those having a limited equipment, it seems absurd to generally equip any department of a large shop with this form of tool which not only costs more than the simple form but which, by reason of its construction, is not as strong and durable. For instance, the carriage has to be so constructed that the cross-slide and tool will be out of the center towards the face-plate, to enable the tool to be used on the periphery of the work when using the full capacity of the lathe. Such a construction is, of course, not so well calculated to give as permanently good results as the form of carriage used on the simple tools. Simple tools of various sizes to suit the general class of work are always more satisfactory and less expensive.

While it is not known positively but that there might have been some valid reason in this instance for such a peculiar shop equipment as the one mentioned, it is pretty safe to assume that the reason for such an abnormal condition of affairs is traceable to the desire of those responsible for the purchase of the tools to have each machine a complete tool in itself, or rather one having a great range of adaptability. This condition is quite evident in many other shops when the immense number of machines equipped with compound rests and Slate taper attachments is noticed. In many cases these attachments represent an investment that makes no adequate return, as in most cases, neither of these is used enough to warrant the equipment of all the lathes of a large shop with them. The work requiring either or both attachments can usually be sent to a few lathes having these features, and the others may just as well, or better, be as simple as possible as far as the carriage arrangement goes.

A good plan which, however, is not generally feasible, is to have the compound rest interchangeable with the plain slide rest of a number of lathes of the same class. Under these circumstances each lathe is normally a plain slide rest with the advantages of stiffness and simplicity of carriage detail. When occasion arises making it desirable to use the compound rest, it is applied without much loss of time and is again removed when the work no longer requires it.

The cost of the compound rest and taper attachment would usually prove a better investment if put into a two-speed countershaft and a variable feed mechanism by which the machinist could quickly change the speed and feed of his machine to suit the work being done.

The importance of the two-speed countershaft as a means of cost reduction on many classes of work is often overlooked. With the best of intentions, the operator may often neglect to secure the proper speed for the work in hand, as it is often a physical impossibility to shift the driving belt to the proper step and at the same time attend to the manipulation of the tool. With the two-speed countershaft, the utilization of the two speeds bearing a considerable ratio to each other becomes second nature and is continually used. Of course, a variable speed countershaft giving a large number of speed changes by minute variations is still more desirable, but as yet the most of these devices, because of certain objectionable features, have not become as popular as they undoubtedly will in the future when improved and reduced in cost.

The importance of the variable feed mechanism is becoming quite generally recognized, and a number of lathe builders are now placing on the market machines which leave little to be desired in this direction.

* * *

The superimposed turrets for battleships win, by the late decision of the special naval board, and they will be placed on the five new battleships. While there is a disadvantage in placing "too many eggs in one basket," by placing four guns in practically one turret, the great gain in arc of fire and concentration of fire seems to have counterbalanced this disadvantage.

# AMONG THE SHOPS.

## SOME OF THE INTERESTING FEATURES OF THE SCHENECTADY LOCOMOTIVE WORKS.

During the year 1899, the Schenectady Locomotive Works, at Schenectady, N. Y., built 355 complete locomotives for domestic and foreign use. Of this number 63 were of the Schenectady compound type, or that having the high-pressure on one side and the low-pressure on the other, with the Pitkin intercepting valve by which the locomotive may be worked as a simple engine when starting a train. With the product of 1899, the total number of compound engines built by the Schenectady company is 239. To accomplish the total result for one year, or nearly one complete locomotive for every day, including Sundays, something over 2,500 men were employed, thus making these works the next chief industry of Schenectady to that of the General Electric Company, which gives employment to about 6,500.

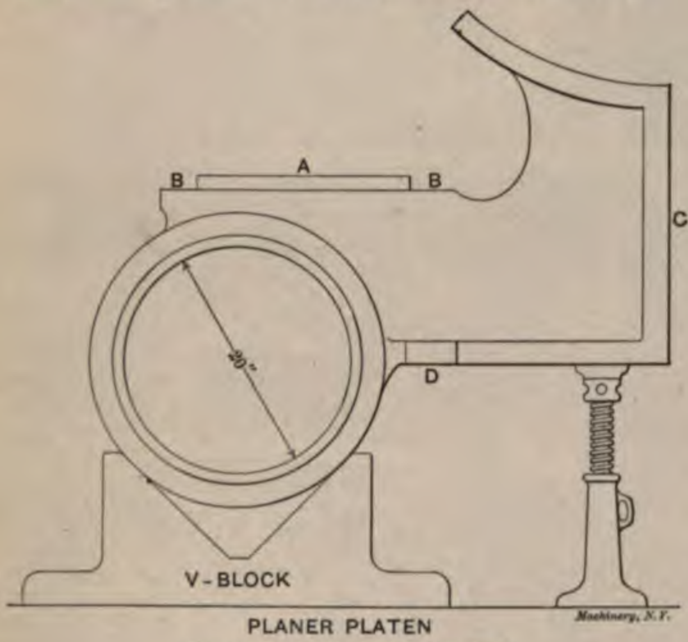


Fig. A. Jig for Machining Cylinders.

In the various views of the interior of the shops shown on pages 368 and 369, that of the foundry is denoted by Fig. 1. The foundry is a well equipped department for the class of work done and is served by traveling and jib cranes. The most remarkable feature noticed in this class of foundry work is the large number of cast-iron flasks that are shaped considerably like a locomotive cylinder, but larger. These are used for moulding the cylinders, and are made from cast-iron on account of the necessity of baking the moulds for a number of hours before pouring the metal. Dry sand moulding has to be practiced on locomotive cylinders on account of the complexity of the pattern and the impossibility of otherwise properly supporting the numerous cores for the tortuous steam and exhaust passages.

The general practice seen here will compare very favorably with that of any other class of foundry work, the successful casting of locomotive cylinders being regarded as one of the most difficult jobs encountered by the moulder.

The cylinders are machined in the cylinder shop shown in Fig. 2. The first operation is the boring of the cylinders, which is done in horizontal machines having traveling bars, to which are secured cutter heads. The flanges are faced in the usual manner with a cross-feed head attached to the boring bar, the feed of which is operated by the usual star-wheel and tappet. After being bored the cylinders are chucked on the planer in V-blocks, as shown in Fig. A, and are supported under the saddles by screw-jacks, which form a convenient and reliable blocking. The flanges at each end of the cylinder are turned to exactly the same diameter, so that when seated in the V-blocks the valve seat will be planed parallel with the bore. In the case of the low-pressure cylinder of the compound locomotive, it is necessary to proceed somewhat differently, as the flange cannot be turned to give the accurate chucking surfaces afforded by the smaller and simpler cylinder. When planing the low-pressure cylinders, discs which fit closely in the counterbores are inserted at each end and held in position by bolts through the cylinder. The ends of the discs are then allowed to rest in the V-blocks, the same as the flanges of the ordinary cylinder. The first planer shown in the foreground of Fig. 2 has a cylinder chucked on the platen in the manner described.

Simple cylinders are always planed in pairs so that, while all work of the same class is expected to be interchangeable, there will be no question but that the two cylinders for any simple locomotive will be alike in all respects. One of the little kinks in planer practice that help to economize time and promote the efficiency of the tools, was observed in the setting of the planer tools, when two heads were being used, so that both tools would either enter or leave the cut at the same time, thus making the travel as little as possible. The pattern for the simple modern locomotive cylinder is reversible; that is, a cylinder may be used on either the right or left side, as desired. This is effected by having the cylinder symmetrical on each side of the middle lateral vertical plane so that whether one end is ahead or the other, the relation towards its mate is exactly the same.

After the cylinders are planed, they are tested hydrostatically to about 400 pounds pressure per square inch. This pressure is obtained in a simple and ingenious method by a combination of differential pistons and cylinders, by which air pressure of about 100 pounds pressure is multiplied in effect until the resultant pressure is that stated. To confine the water so that the cylinder bore, the steam passages and the exhaust passages can be tested, cast iron blocks are bolted over the openings at the valve seat face with sheet rubber packing underneath and covers are also fastened over the steam and exhaust nozzles on the saddle. In this way each cylinder is carefully tested, and any leaks are located before the work goes any further. If the leak is a small one, owing to a sand hole, it is plugged, but if it be a crack or a porous spot the casting is condemned. The pressure is allowed to remain on each cylinder for a number of hours so that the smallest leaks are detected and remedied. The design of all the cylinders made here is such that the steam and exhaust passages are separated by an air space, which feature of isolation has an important effect in lessening the losses from condensation.

In this department, the steam chests are planed and drilled. The grooves for the copper joints are planed so a copper wire gasket about ¼" diameter will sink into the grooves to nearly one-half its diameter. To facilitate this operation and also the regular planing work, a simple chuck is used, which is shown by a top view in Fig. B. It consists of two square flat plates, the lower one of which is fastened to the planer platen and the upper one mounted on it with a central pin C as a pivot. A pin B at one corner locks the two together and T-slots D D D D are provided for clamping the steam chest in place. When the chest has been planed off and the gasket grooves made in one direction, the locking pin is removed and the chest with the upper plate is swung around to a position at right angles to that

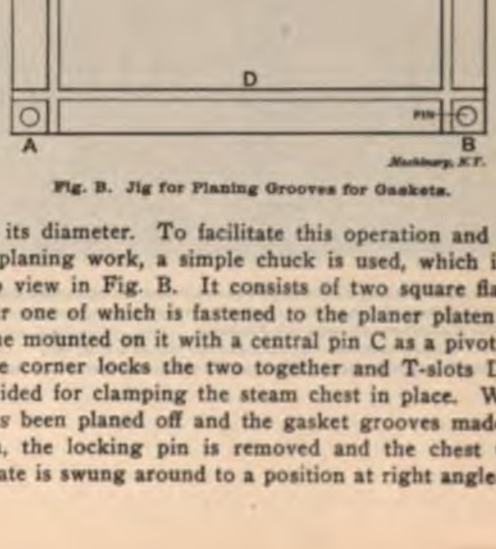
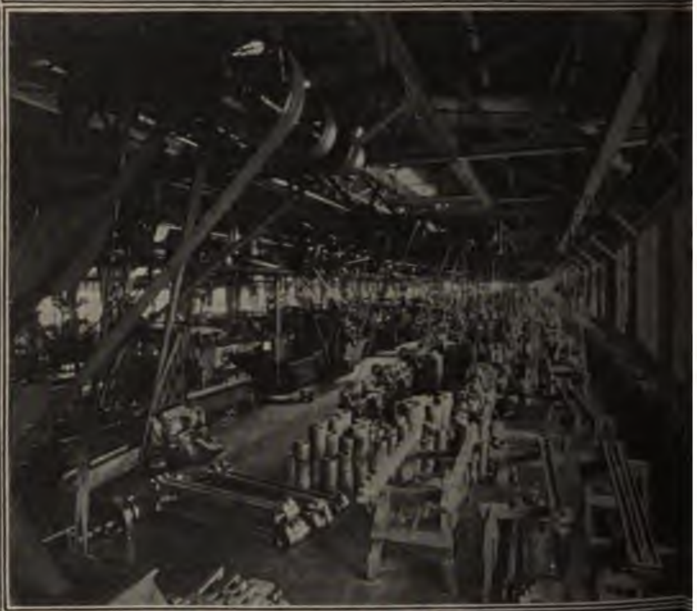
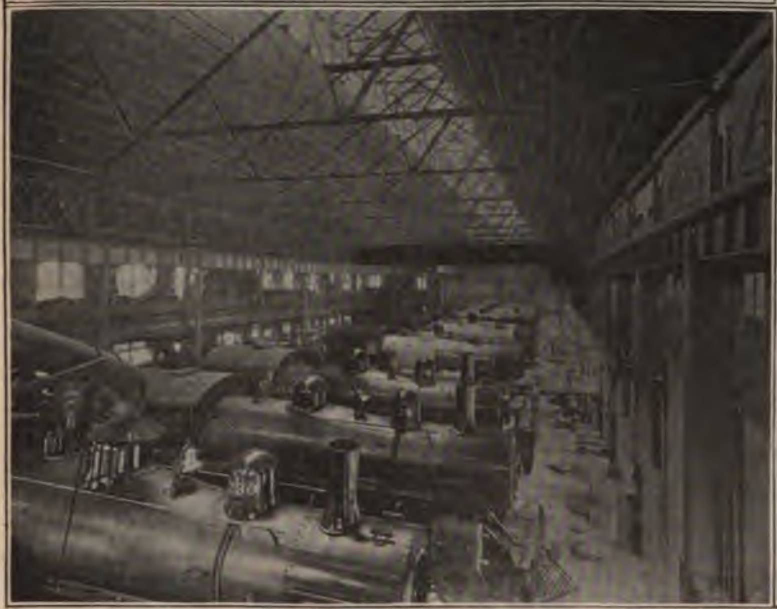


Fig. B. Jig for Planing Grooves for Gaskets.





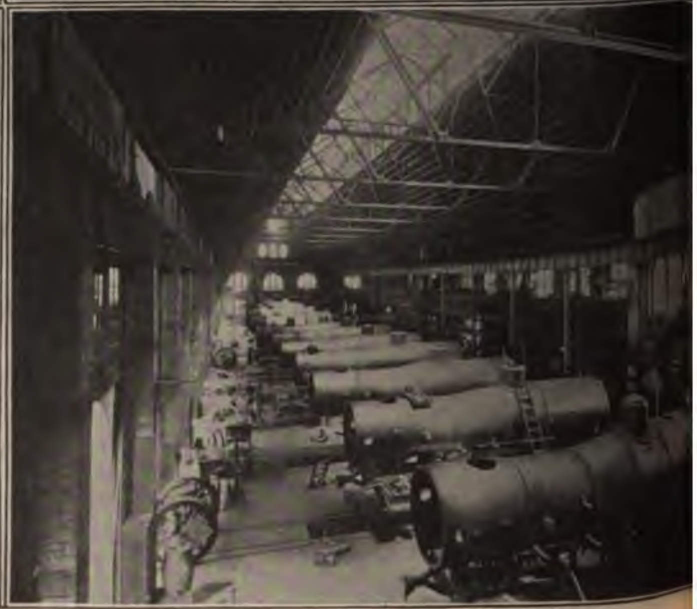


Fig. 1. The foundry. The flasks in front are for cylinders and are made of cast iron. After the mould is made for a cylinder the flask and mould are baked for a number of hours in a furnace.

Fig. 5. Heavy hammer department for frame work, etc.

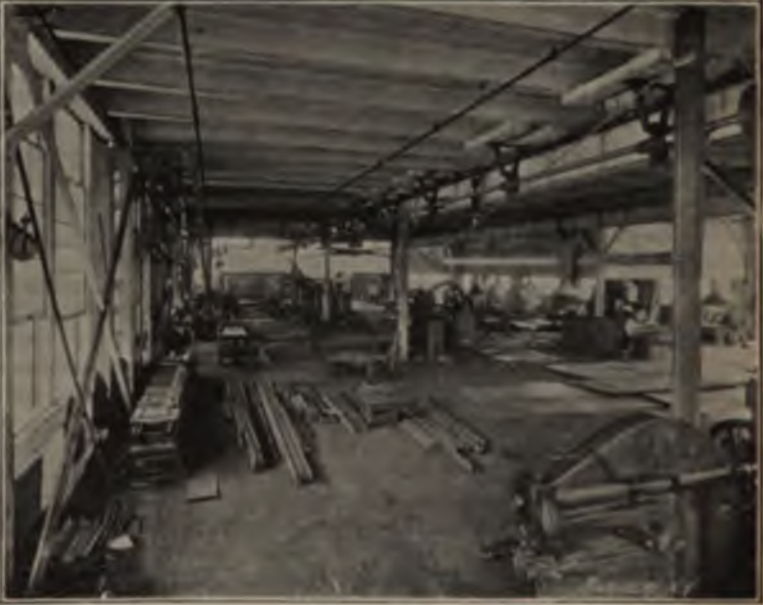
Fig. 9. View of the erecting shop, showing engines ready for delivery.

Fig. 2. Cylinder shop where the cylinders are bored and planed. The cylinder to the right in the foreground is for a compound locomotive.

Fig. 6. Department called the rod shop, where the main and parallel rods are machined and finished. The piles of rings in the foreground are the brass bushings for the solid-end rods, which are forced into place by hydraulic pressure, and which when complete take the place of the older form of strap and key rod ends.

Fig. 10. View of the erecting shop showing engines in process of erection.

**VIEWS OF THE SCHEN**



Blacksmith shop No. 1, where the frames are forged.

View of the first machine shop, showing triple-head frame slotter and locomotive frames in the foreground in various stages of manu- The frame slotters, of which there are two, have traveling heads, the aining stationary on the bed-plate.

. Another view of the first machine shop, showing the department -wheel work.

Fig. 4. No. 2 blacksmith shop, where the lighter iron work is forged.

Fig. 8. Boiler shop served by two traveling cranes. This department contains an immense hydraulic press, which forms the shapes in sheet metal shown in Fig. 13.

Fig. 12. Tank shop, where the sheet metal work for the tenders is done.

## OTIVE WORKS.

previously occupied and the locking pin again engaged with another hole provided in the base.

The forging of a locomotive frame is a difficult piece of work and one requiring special aptitude and experience in the work. Some of the best frame forgers in the Schenectady works are not blacksmiths in the sense of being able to do any class of work, but are, in many instances, helpers who have never worked on any other class of work but this. When the opportunity has presented itself, they have been promoted to directing the work, and are thus specialists in heavy and intricate forging and welding. Steel frames are now used somewhat instead of wrought iron, being cast in the form required.

The views of the blacksmith shops given in Figs. 3, 4 and 5 will give an idea of the appearance and arrangement of the forges and steam hammers. The five large hammers shown in Fig. 5 have heating furnaces over which are steam boilers heated by the waste gases, and which supply the steam for the hammers and other purposes in the shop.

The frames are planed and slotted all over. While the planing of the frames is not especially interesting, the slotting of the jaws and other parts not operated on by the planer is somewhat out of the ordinary. This work is done on gang slotters, Fig. 7, each having three traveling heads and each head being usually in charge of a mechanic. The frames are always machined in pairs or, as sometimes may occur, two pairs are piled up and bolted to the bed-plate. The frames remain stationary, and all feeds of the slotter tool depend on the longitudinal or lateral travel of the head. The oldest frame slotter was observed to have been imported from Leeds and the other is the product of Bement & Miles. The period when the first machine was purchased probably marks the time when special tools of this class were all imported, the period of the second that when special machinery of the heavier types began to be supplied by our own builders, while the present is the time when American shops not only supply their own needs but also a good portion of those of other countries.

An interesting department is that seen in Fig. 6, where the main and parallel rods are machined. The forgings for this class of work are made extremely rough, no attempt apparently being made to have the forgings conform closely to the shape of the finished product as it has been found cheaper to approximate the general shape and depend on the machines to remove the excess of metal. The milling operations carried on here are done largely with cutters made from low grade, or what is generally known as machinery steel. The cutters are made up as usual and are case-hardened to a considerable depth. The loss from breakage and cracking when hardening is practically nothing, and the work of the cutters in steel and wrought iron is said to be highly satisfactory. The cutting edge is found to be about as durable as with the higher grades of steel, the breakage of teeth is greatly reduced and the first cost of the cutter is considerably less than those made of tool steel, especially those made in the larger sizes, as in them both the cost of the material and the time required for machining is more apparent.

When it is considered that these cutters are used by contractors who take charge of the production of certain parts at a piece price, paying the men employed by them, but having all their tools and material provided by the company, it will be understood that if the cutters give satisfaction under these conditions they ought to be very reliable for any other kind of service. Some cutters are also used made from cast iron with inserted Mushet steel cutters. All the parallel rods are made in the I-beam section and are milled from the solid metal. The I-beam section of the main-rod tapers from the cross-head to the crank-pin end so that it is necessary to plane out the metal instead of using the milling cutter. It appears that here is an opening for some inventor to devise a form of milling cutter which will expand or contract in width as it travels along the length of the cut, a probably not impossible feat, but perhaps one not practicable in the present state of the art and when submitted to the tender mercies of many machine operators.

The rod ends are milled on the exterior or vertical milling machines, all the shapes being arcs of circles or combinations of them, so that no special devices are necessary. The oil cups are machined from the solid metal so that they form an integral part of the rod. This feature of construction is rendered desirable by the modern high speeds which are often sufficient to break off the neck of the ordinary brass cup on account of the centrifugal force developed. The loss of an oil cup on an express locomotive is a serious mishap, as the absence of lubrication might easily cause a ruined crank-pin and a considerable delay on fast trains, if nothing worse. As these cups are made this danger is obviated, and as the covers screw into the top with a fine thread of large diameter, they are also quite secure. The boss for the oil cup is first drilled and bored out to the desired size. The exterior is then turned off while in position under the drill-press by a tool having a teat which engages with the bored hole and having an exterior cutter to turn the outside. The feed is obtained from the drill-press spindle driving the tool.

The ends of the rods are bored considerably larger than the crank-pins and bushings of anti-friction metal such as brass, bronze, Ajax metal, etc., pressed into the rods by an hydraulic press. No provision for wear is allowed on the parallel rods of the modern locomotive, as it has been found more economical both in first cost and maintenance to discard the halved brasses, strap and key arrangement. The latter have both the advantage and disadvantage of being easily adjusted for lost motion. In the hands of the careful engineer, the strap rod is an economical construction, although quite expensive in first cost; but when the adjustments are made by careless or ignorant persons, the results are disastrous, especially on engines having more than two pairs of coupled driving wheels. In the case of the solid end rods, the bearings are allowed to run in practice until the lost motion becomes considerable and then are repaired by removing the old bushing and substituting a new one. The simplicity of the arrangement and the impossibility of the engineer making improper adjustments makes these forms of parallel rod practically the standard in the present American practice.

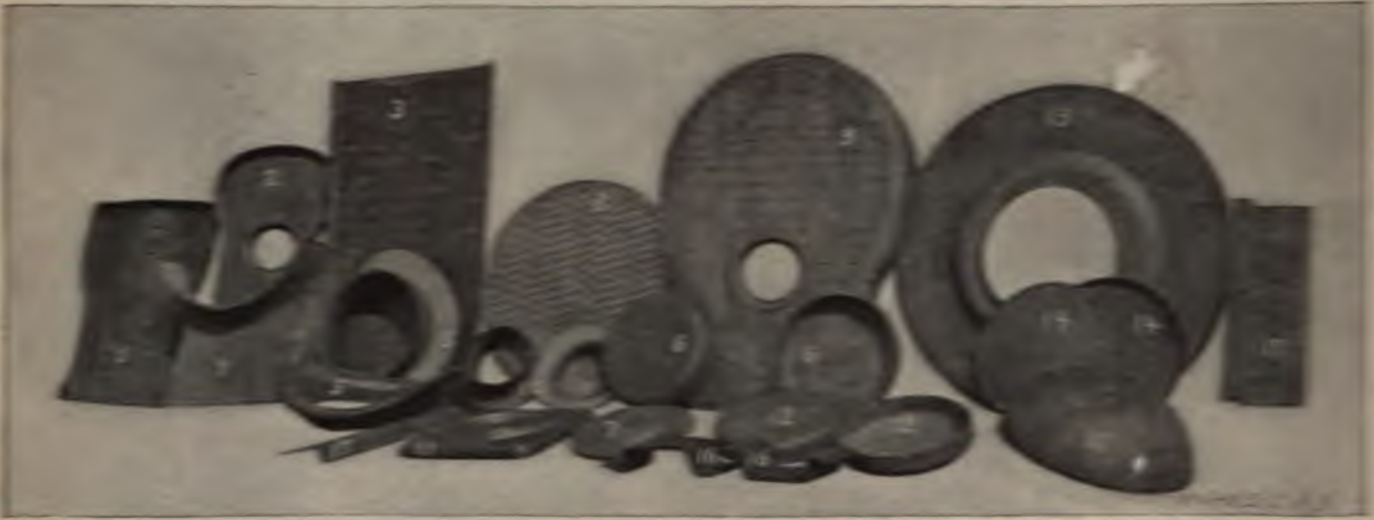


Fig. 12. Samples of the Pressed Work now used in Locomotive Construction.

the main or connecting rods it is necessary to adhere to justable form, as here lost motion would be a serious de- account of the reversal of thrust at the end of each stroke. again, the danger from improper adjustment on the con- g rod is not as great as on the parallel rods.

nstance of "making a piece stronger by making it weaker" oticed in the form of the piston rods of one locomotive built for a Western road. The piston rods were "necked just outside of the cross-head, by which means greater ity is obtained at a point where the bending action is al- concentrated. In connection with the subject of piston method of construction demanded by some railroad com- is worthy of comment, and that is of having the piston pers ground into the cross-heads with oil and emery. Just dvantage is gained over a good lathe fit on this work is than the writer knows, but if the idea is, as it apparently s to be, to get a perfect fit, it is exactly contrary to some d practice. It is believed in some quarters to be better e to fit a taper piston rod slightly tighter on the small an at the shoulder, so that portion of the rod embraced keyway shall be in compression rather than in tension. In ent, it appears according to the canons of modern prac- though grinding piston rods into the cross-heads is a e that should speedily become obsolete.

boiler shop is an extensive building having galleries at the nd provided with two traveling cranes for handling boilers aterial. Chipping, calking, tapping stay-bolt holes, screw- stay-bolts and other work is done by compressed air supplied by a Norwalk compressor. Perhaps the most g tool in this department, both in its appearance and the urned out, is the huge hydraulic flanging press made by organ Engineering Co. With it are formed many shapes that few years ago were made entirely from castings. Boiler dome connections, steam chest casing tops, flue sheets, r head casings, etc., are formed by pressure while hot. samples of the work of this press are shown in Fig. 13. dvantages arising from pressed work of this kind are ous. In the case of boiler front ends, the weight is con- ly lessened, as is the case with many other parts. This esirable condition, although locomotives are continually made heavier, but in the construction of the locomotive s no trouble to get weight. The effort is to get rid of uous weight where not needed and put into the boiler the demands are never satisfied. Again, flue sheets and portions of the boiler flanged by one or two operations gher and freer from the defects incident to the hammer- d mauling that occur when hand work is the rule.

igs. 9 and 10 are given two views of the erecting shops from opposite ends. This department is served by travel- nes having sufficient capacity to lift and transport a loco- from one track over the others and deposit it wherever d. A transfer table on a track on the outside of the shop the completed locomotive to the switches where it can vered to the main line of the railroad.

finely equipped drawing rooms recently built were de- in the February issue of MACHINERY and constitute in resent state an important addition to the productiveness of ncern. The drawing department is an important depart- f any manufacturing firm and particularly so in the case comotive shop as the great variety of designs demanded erent roads and the constant struggle to increase the cy and capacity of the locomotive make the labor in the g room never ending.

onclusion, it may be said that the modern American loco- which the Schenectady company has done not a little to , never fails to win general admiration, and when its de- carefully studied, the more the mechanic will understand ptibility to the arduous conditions of service. At first, miliar with locomotive practice, he may be disposed to e the general looseness of the working parts until he tands that this condition is not a defect, but an absolute ty on account of the more or less general unevenness of dbed and the prevalence of dust which, were the bearing fitted without lateral movement, would cause binding and . Judging the locomotive by its work and the results llow, it may easily be regarded to be, in many ways, the t mechanical triumph of the present age.

## ITEMS OF MECHANICAL INTEREST.

### NOTES GLEANED FROM VARIOUS SOURCES.

From observations made in the General Electric Works at Schenectady, a twenty-five foot electrically driven boring mill was found to absorb 3 H. P. when turning the periphery of a large cast-iron spider. A similar mill of twenty feet capacity absorbed 1 H. P. when operating on light work. Nine planers 48" x 48" grouped and driven by one motor through line shafting, were found to require an average of 45 H. P. of which probably nearly 1-3 was absorbed by the shafting and belts. A great difference has been found in the power required for planers of equal capacity, but of different designs. Those having sharp V-slides on the platen were found in some instances to require as much power when running light as others having flatter slides did when doing heavy work. The actual power required to force the tool through the cut on a planer is a small proportion of that required to overcome the friction and inertia of the moving parts.

In the Gray shops, Cincinnati, one of the large planers was adapted for work that will not pass between the housings by the addition of two additional uprights, which rest upon a sole plate under the forward end of the planer. The sketch is a plan view of the planer and sole plate. The long, horizontal parallelogram represents the planer bed, under the left hand end of which is the sole plate, as indicated. The two uprights slide in or out on the sole plate, as desired, in order to be located properly for the work, and thus the ends and sides of large and heavy pieces, far beyond the ordinary capacity of the planer, can be machined. This arrangement is not uncommon, but it is worthy of even more extended use.

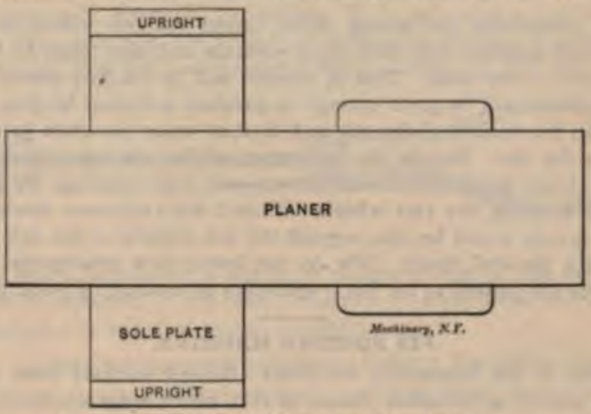


Fig. 1. Plan of Planer and Sole Plate.

Alloys of possible value, especially for castings, have sometimes been discovered in the course of research in the Mechanical Laboratory of Sibley College, Ithaca, N. Y. Two of these were recently described by Dr. Robert H. Thurston, in the "Sibley Journal of Engineering," as follows: "'Alzinc,' as it has been generally termed, consists of two-thirds aluminum and one-third zinc. It has the general working quality of a very good cast-iron, but has only about four-tenths its weight (S G. 2.9), works beautifully in the lathe and on the planer, and can be cast very fluid at a comparatively low temperature, making remarkably sound and even castings. Its tenacity is about 25,000 pounds on the square inch and, when warm, it is ductile, but it is brittle at low temperatures. Its cost is about two-thirds of aluminum. Another alloy, 'alzinctin,' contains 50 per cent. aluminum, 25 tin and 25 zinc. Its specific gravity is 3.17 and its cost is about 80 per cent. that of aluminum, a trifle higher that the preceding. It has a measurable ductility, even when cold, about 5 per cent., and is a better material for smaller parts and where some ductility and elasticity are desirable. Its tenacity is about 20,000 pounds per square inch. Both alloys, at the boiling point of water, become very much tougher and more ductile. No copper can be employed in making these alloys as it proves wholly deleterious."

### AUTOMATIC FRICTION GEARING.

The "Mechanical World" publishes a description of a novel friction gearing in which the pressure between the two friction wheels is automatically regulated by the amount of power transmitted. In the sketch W is the driver which turns in the direction of the arrow. Wheel T is free to rotate or slide upon shaft

A within reasonable limits, and the shaft is cut with a course-pitch screw on which is the nut B. This nut slides in grooves F in the friction wheel T and hence when the nut turns, the wheel must turn also. A spiral spring S inserted between the nut B and wheel T tends to keep these two elements apart.

Suppose that wheel W turns in the direction of the arrow and that the driven shaft A meets with some resistance to rotation. At first wheel T and the nut B are turned through the frictional contact between the two bevel wheels, but the shaft A does not turn because of the resistance that it must overcome. The nut, therefore, moves to the right, owing to the action of the screw, and compresses the spring, which causes the two wheels to be pressed together with still more pressure and also tends to lock the nut to the shaft. That is, a point will be reached where the end thrust will be great enough to produce sufficient friction between the threads of the nut and shaft to cause the shaft to turn with the nut. Should the resistance of the shaft increase, the end thrust would increase to correspond, thus reducing the slipping between the two wheels. Should the resistance decrease, the spring would be able to push the nut slightly to the left and reduce the end thrust. We do not know how practicable this device has proved to be, but it embodies an interesting principle.

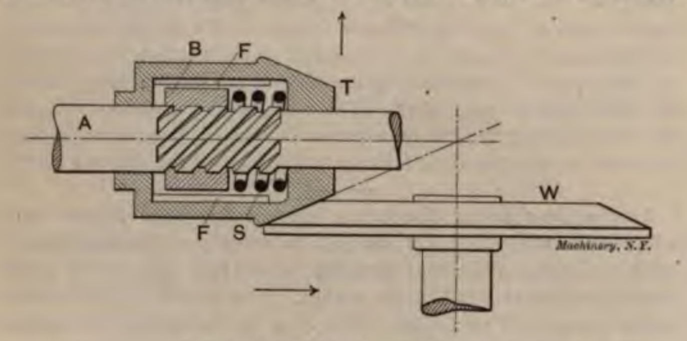


Fig 2. Detail of Automatic Device.

## PIN SORTING MACHINE.

One of the interesting machines (though ancient) seen in a pin factory at Winsted, Conn., is that which separates the bent and defective pins from the perfect ones. The principle is illustrated in the accompanying sketch which shows the upper side of a number of parallel leather belts about 1½" wide, having cemented fastenings so that no lacings interfere with the separating action. The belts all travel slowly in the same direction, being driven from a common shaft and the pins are dropped on their upper surfaces from a hopper at the left end. During the travel towards the right, the perfect pins roll off while the bent and defective ones continue to the end where they are dumped in the scrap box. The separating action is assisted by giving the pulleys C C C C, etc., and D D D D, etc., a slight wabbling action as they turn, thus communicating a rocking action to the belts. Often a pin will be observed to go through the machine to the scrap box that appears all right, but when closely examined, it will almost invariably be found that if not slightly bent the head is eccentric or has a fin which prevents it from rolling, which is, of course, the secret of the machine's action. The perfect pins roll off of the traveling belts, while those that are at all crooked remain until they are deposited with the scrap.

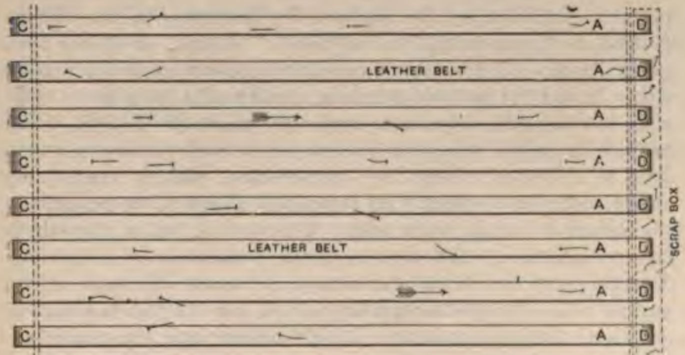


Fig. 3. Plan of Pin Sorting Machine.

## A DELICATE INSTRUMENT.

An interesting little instrument has been devised and is used by Prof. C. H. Benjamin in the laboratory work at the Case School of Applied Science, Cleveland, Ohio. It is described in the notes on laboratory practice by Prof. Benjamin, which are published by Charles H. Holmes, Cleveland, Ohio. The instrument is an extensometer for measuring the extension or contraction of a specimen during a tensile or compressive test. As the distortion in such cases is usually very small previous to the point where the elastic limit is reached, it is necessary to have a delicate means for measuring it. Micrometer calipers are generally used similar to those described by Prof. Miller in his article upon "Testing the Strength of Materials" in the March number of this paper. It is desirable, however, to have an instrument which does not require repeated adjustment and this end is accomplished in the one illustrated in the accompanying sketch.

It consists of two vertical bars, F F, connected together by two round pins at one side. These pins are threaded for thumb nuts which serve to close the bars together, and spiral springs between the two bars serve to separate them. Each bar is provided at the lower end with a steel point to bear on the specimen T and at the upper end with a light steel lever in a horizontal position. The two levers are marked A and B in the sketch. Each lever is provided with a steel point similar to those on the bars. Lever A is pivoted at point a, to the left of the steel point which bears on the test specimen, and lever B is pivoted at point b to the right of its steel point. Lever A therefore is of the third order and its outer end will raise when the specimen stretches and gives the steel point a slight vertical movement. Lever B is of the first order and its outer end will be depressed for a corresponding movement of its steel point. It is evident, therefore, that when the bar stretches very slightly the extreme ends of the levers will greatly magnify this movement. On the end of arm B is a scale S. During a tension test this scale moves downward and the pointer A moves upward, making it feasible to read ten-thousandths of an inch upon the scale per inch length of specimen. It is evident that with this instrument the spaces on the scale can be twice as far apart for a given length of lever arm as would be necessary if the scale were stationary and the pointer A alone moved.

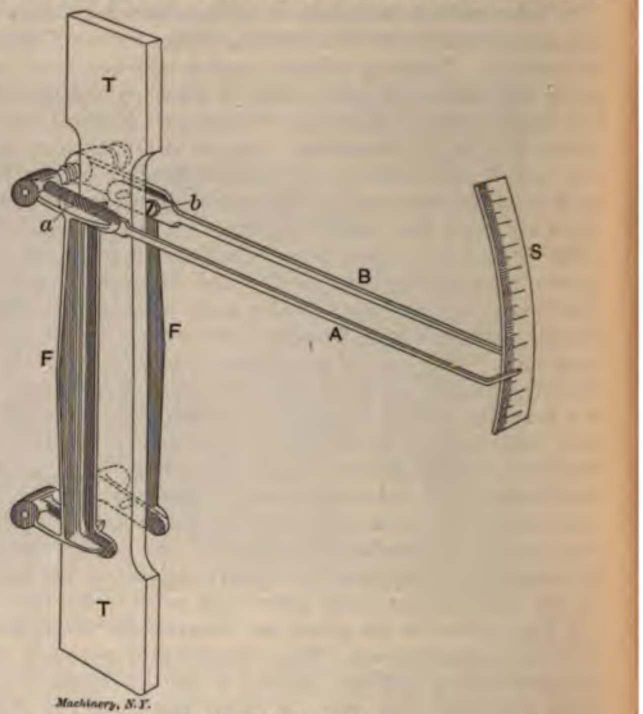


Fig. 4. Extensometer.

* * *

In most shops bar stock is placed in horizontal racks and when a piece is wanted it must be pulled out its full length and then replaced. If the piece happens to be at the bottom of the heap, so much the worse. At the Cleveland Twist Drill Co.'s works, where a large quantity of round stock must be carried, all the medium and large bars are stood on end in suitable racks. This makes a very convenient arrangement where the bars are stiff enough to stand without bending.

## SHOP KINKS.

### A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

**Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.**

To encourage our readers to send more descriptions and photographs of good shop kinks and handy devices, we will give contributors the privilege of selecting from the appended list of desirable machinists' tools, according to the value of the different devices submitted.

To compete, it will be necessary to observe the following conditions:

1.—All descriptions shall be written on one side of the paper only.

2.—The necessary sketches to illustrate the device shall be made on separate sheets from the written matter.

3.—Tools shall be chosen from the following list, as no option in the selection of other tools can be given.

All contributions to this department will be graded, according to value, into four classes. Contributors will be informed by mail during the month following publication, from which class they may make their selections. Cash payment will be made in all cases, if preferred.

| | | List Price. |
|---|---|---|
| 1. | Starrett's No. 9 combination square, 12-inch blade, with center head and bevel protractor | $4.00 |
| | Sawyer's No. 100 surface gage with 12-inch and 18-inch spindles | 3.50 |
| | Slocomb's No. 17 outside micrometer caliper | 3.50 |
| 2. | Sawyer's No. 39 combination square with 12-inch hardened blade | 2.50 |
| | Starrett's No. 56 tool maker's case-hardened surface gage, without auxiliary guides | 2.50 |
| | Slocomb's No. 12 internal micrometer caliper with depth gage attachment | 2.50 |
| | Starrett's No. 11 combination square, 12-inch blade, with center head | 2.00 |
| 3. | Slocomb's No. 11 internal micrometer caliper | 1.75 |
| | Starrett's No. 13 4-inch square, with two blades | 1.65 |
| | Starrett's No. 15 universal bevel | 1.50 |
| | Sawyer's No. 18 spring tempered rule, 12 inches long | 1.25 |
| 4. | Starrett's No. 40 screw pitch gage | 1.00 |
| | Sawyer's No. 19 flexible rule, 9 inches long | .90 |
| | Starrett's No. 79 outside spring caliper, 4 inches | .75 |
| | Starrett's No. 73 inside spring caliper, 4 inches | .75 |
| | Starrett's No. 83 spring dividers, 4 inches | .75 |

### METHOD FOR THREADING SMALL SCREWS.

"S. C. Rew" says: I enclose a kink for threading very small rods. A four-jawed universal chuck is screwed on the spindle of the head-stock and the die is held in the chuck.

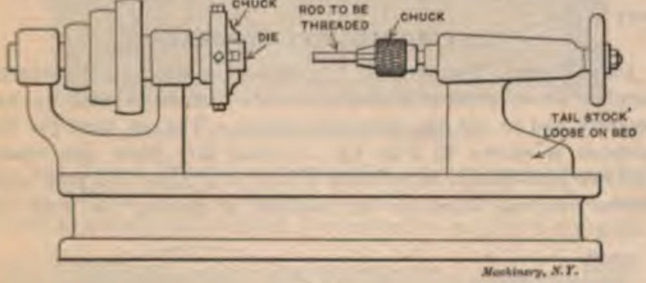


Fig. 1.

The tail stock is not fastened to the bed and the rods are held in the chuck. Where a number of small rods are to be threaded this will be found a very convenient and rapid rig. The tailstock is pushed up until the rod touches the die, after which the die does the feeding. Reversing is done by countershaft.

### A GOOD COMBINATION TOOL.

C. W. Shelly, Peterboro, Ont., says that Starrett's lock-joint hermaphrodite calipers No. 42 answer the purpose of three separate tools. By bending two extra points A and B into the proper shape it will do for inside calipers and also as a gage for distances between holes and slots. The illustration Fig. 2 will make this clear. It economizes room in the tool box and also saves expense.

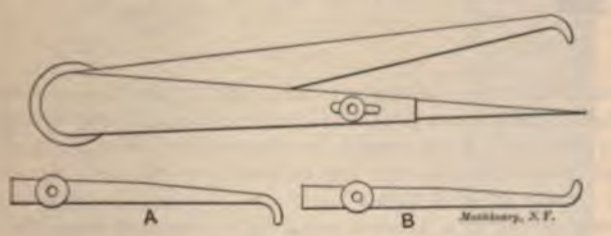


Fig. 2.

### PLANER POPPETS.

W. W. Cowles, Torrington, Conn., says that sketches Figs. 3 and 4 show two handy poppets for the lathe, planer, milling machine, surface grinder, etc. The poppet shown in Fig. 3 is made of cast steel as cast-iron is too brittle. The illustration shows its form clearly. The poppet shown in Fig. 4 can be made very cheaply as a number can be formed at once. It is made from a bar of machinery steel any length and 1¼" thick by 2½" wide. The bar is planed so that a cross-section is of the form shown by the full lines and then is sawed into sections about 1¼" wide. A half-inch screw is large enough for this size. A half-dozen such poppets are very handy to have around a planer.

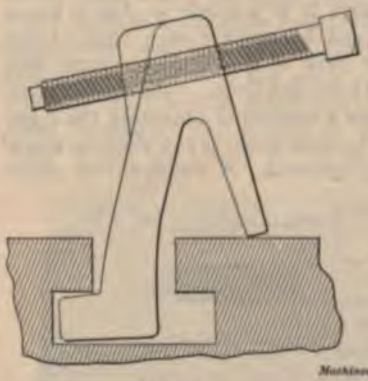


Fig. 3.

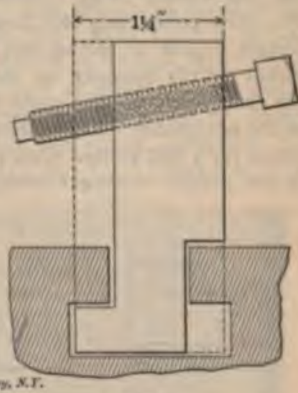


Fig. 4.

### A HANDY TOOL.

George I. Babcock, Providence, R. I., says that a handy tool for the pattern maker to use for rubbing in corners is made by taking a steel ball and inserting into it a shank of stiff steel wire on which is mounted a handle as shown in Fig. 5. As the balls can be obtained in any size, a number of these tools of various sizes can be supplied to suit any fillet.

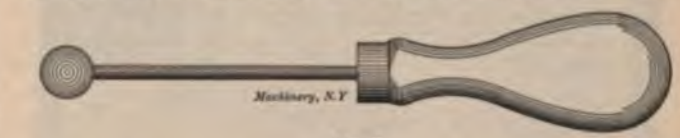


Fig. 5.

### LATHE TOOLS FOR TURNING CIRCULAR GROOVES.

H. J. M. describes two forms of lathe tools that are well adapted for accurately turning grooves or fillets of any desired radius. The tool shown in Fig. 6 has a circular cutter B which is turned with a shank fitting the hole through the holder A and is held in position by the nut C on the under side. The cutter B is turned slightly tapering for clearance and can be made concave on top or can be ground to an angle as shown. As these cutters are easily turned in a lathe to exactly any diameter required, it is best for accurate work to have one for each size of radius required. When circular grooves of a larger diameter are required than would be practicable to turn with a forming tool, the tool shown in Fig. 7 is well adapted for the work. The tool B can be adjusted by loosening the set-screw E. The turret D fits freely in the holder A, which is held in the regular toolpost of the machine. The end of the shank of D is fitted with a washer E having a hole fitting over the flattened side of the screw. This prevents the nut C from being moved from its proper adjustment by the revolving action of the tool when cutting the groove. A wrench G is provided to fit on the hexagon shape at the top of the turret D to enable the operator to turn it with facility.

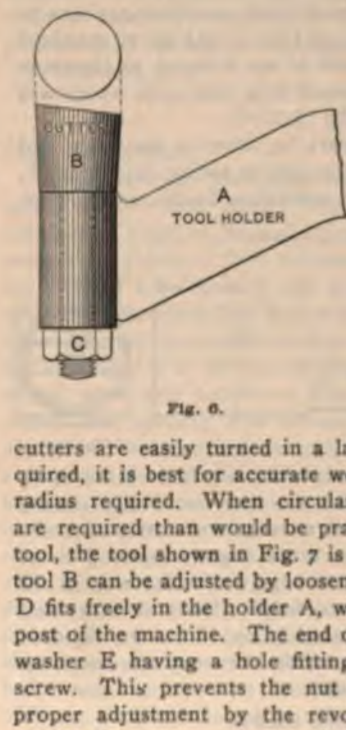


Fig. 6.

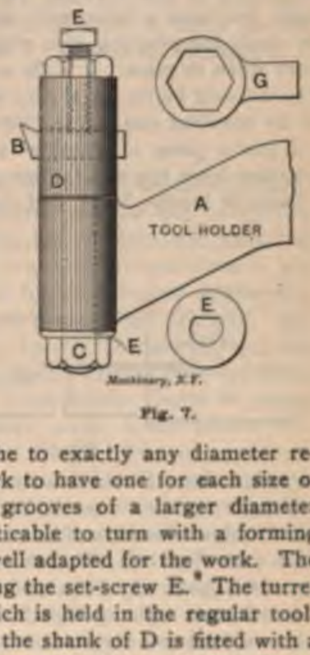


Fig. 7.

### HANDY DIE FOR THE BLACKSMITH SHOP.

"G" illustrates a simple and convenient die for the blacksmith shop by Fig. 8. These dies can be made for a variety of shapes, the one shown being intended for pins like that shown at A. The loop connecting the formers B B is made so that it has a certain degree of springiness and opens after each blow of the sledge or tilt hammer on the back of the formers. Such dies are extensively used in some shops and form a valuable addition to the equipment. Fig. 9 shows a method of obtaining the right throw for a belt shifter when the head room is too short to allow of the proper leverages being obtained. A wrought-iron piece A is forged with a boss, through which is drilled a hole for the rod A carrying the belt fingers. A set-screw C holds it in position. The length of A is made such that it may be connected to the shifter lever at a point that will allow the belt to be shifted with a convenient movement of the shifter lever.

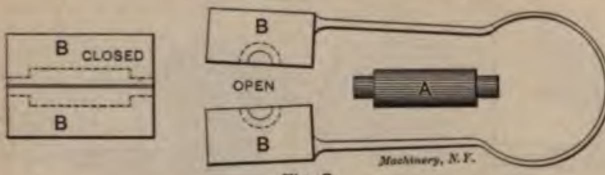


Fig. 8.

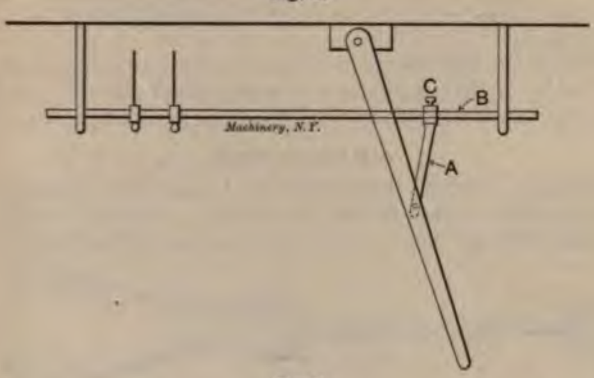


Fig. 9.

### LAPPING HOLES WITH EMERY CLOTH.

Lawrence E. Cutter, San Francisco, Cal., sends a shop kink which has been found useful by him. He says that while there is nothing very brilliant or new about the idea, by means of it a very creditable job was turned out.

We had a number of bronze valve liners to bore and turn which were 18½" long by 2" bore by 2½" diameter. They were bored with a cutter bar and rosebit reamer on a hollow spindle lathe, but were a little small when finished, as allowance was to be made for pressing into place so they would be 2" standard bore when in place. I made a sort of lap of wood, as shown in Fig. 10, and by its use a very smooth hole was made which was of the required size.

I got a piece of wood 2" square by about 2 feet long and whittled down the end (or turned would be better) for about 3", a loose fit for the holes, and then somewhat smaller in diameter to within about 3" of the other end, which was left square to be held by a monkey wrench. A slot was then cut wedge shaped at the end, as shown, and fitted with a wedge and a strip of emery cloth (see Fig. 11). The end was made slightly tapering so as to readily enter the hole, and the wedge was hammered in till the end was a tight enough fit in the hole. Plenty of emery and oil were used and the holes were quickly lapped out the required size. The whole thing was made inside of twenty minutes, and, although very simple, it did the work.

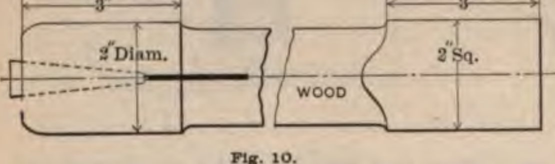


Fig. 10.

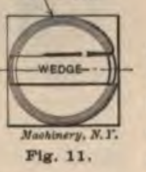


Fig. 11.

### TOOL-SETTING GAGE.

Joseph Aspenleiter, Cincinnati, Ohio, sends a description of a simple tool, by the use of which, he says, there is no danger of turning a piece of work too small at the beginning of the cut and which is also a time saver, as there is no need of trying the calipers two or three times to see if you have the right size. Simply make your lathe tool touch point A Fig. 12 when the gage is against the tail-stock sleeve or the mandrel on which the work is turning. Suppose you have a number of pieces to be turned to the same size, such as large or small pulleys, gear sectors where the calipers cannot be used, etc., simply turn the first one to the desired size, then set the tool from the mandrel to the cutting edge of the lathe tool. When you turn the next piece, set the lathe tool to the point A and you will have the correct size. Further explanation is unnecessary, as the accompanying sketch will give a clear idea of the tool which any machinist or lathe hand can easily make for himself and will find very useful.

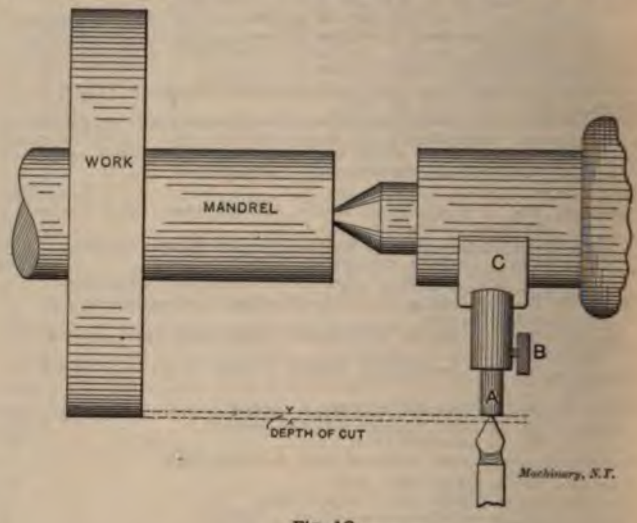


Fig. 12.

### CUTTING MULTIPLE THREADS.

John Bissett, Haildon, N. J., refers to a letter in the March number about cutting multiple threads and states that he has recently had to cut 350 quintuple screws. The rig used for the purpose is shown in Fig. 13. A small face plate was made, and five equi-distant holes were drilled in a circle and pins were driven into the holes for the purpose of driving the work, as indicated. A special dog was used with a "tail that could wag." That is, there was a piece T pivoted in a slot and kept in position by a spring. After cutting one thread the piece T would be moved out to enable the dog to pass by to the next pin, when, by letting piece T spring back into position, the next thread could be cut at a distance equal to 1-5 the lead from the first one.

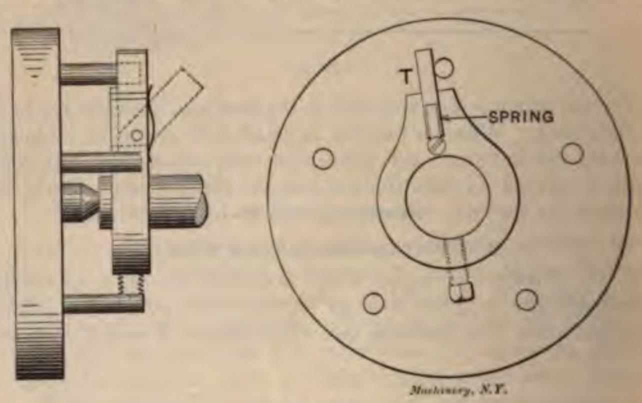


Fig. 13.

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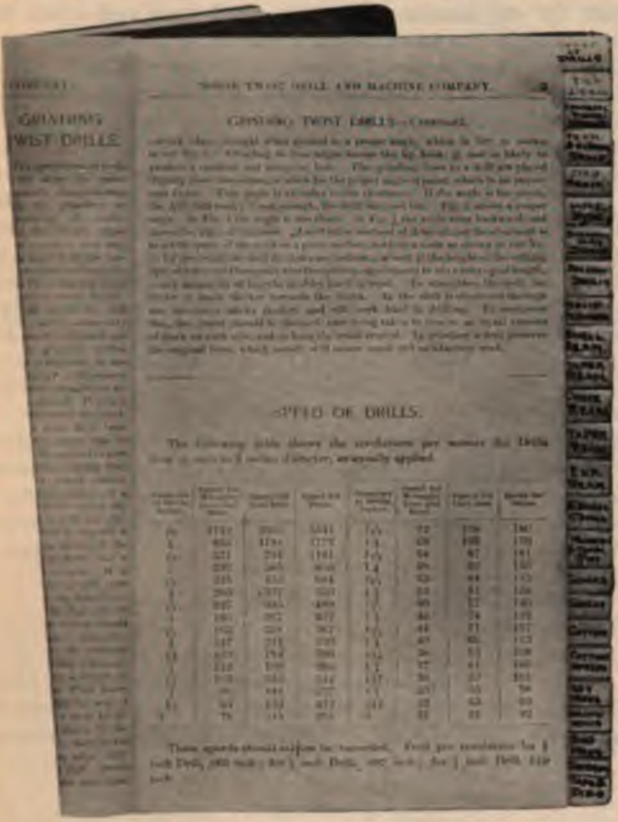
It is reported that the North German Lloyd Steamship Line has placed an order with the Vulcan Shipbuilding Company of Stettin, Germany, for an ocean liner that will eclipse any vessel ever built in regard to size and power, while its speed will exceed that of any other vessel in the Transatlantic trade. The length of the new vessel will be 752 feet and it will have propelling engines of 45,000 H. P. The average speed to be maintained is to be 25 knots or practically 28¾ common miles per hour. This rate of travel compares favorably with the average railroad speeds between terminal points.

# LETTERS UPON PRACTICAL SUBJECTS.

## MARGINAL INDEXING FOR CATALOGUES.

*Editor* MACHINERY:

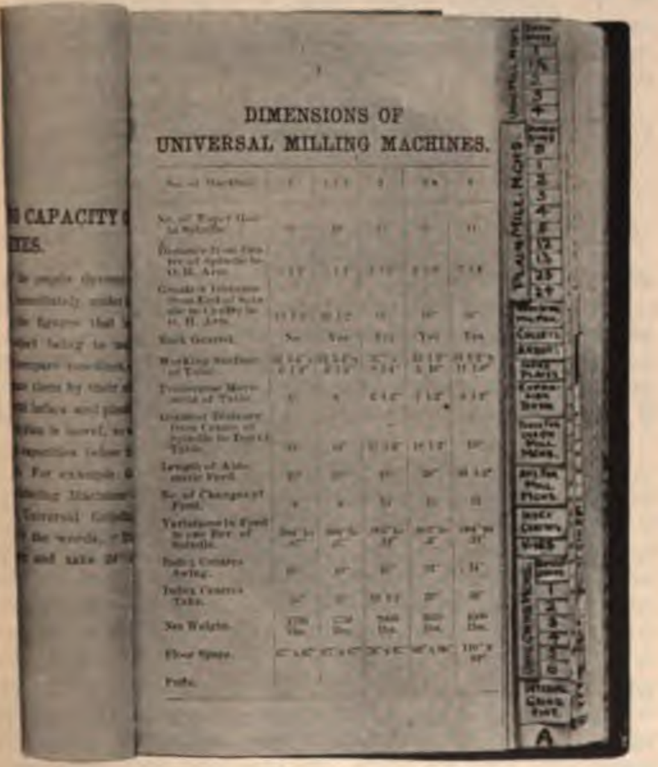
The following scheme was adopted by me for selecting tools for automatic screw machines. With each new job it was necessary to give the foreman data for cams, box tools, drills, taps, etc., and I was obliged to continually refer to catalogues for sizes of such tools. Not always being able to find just what was wanted as quickly as I wished, it occurred to me that a marginal index would be a help. So I took a Morse Twist Drill catalogue and indexed it as shown in Fig. 1. The index was printed with drawing ink and the surface shellaced. In order to strengthen the edges I pasted an additional thickness of paper on the back along the index edge. This proved so satisfactory that I indexed some other catalogues that I have occasion to use quite often, one of which is the Brown & Sharpe Mfg. Co.'s catalogue. Even with the great variety of machines and small tools, an index can be made as shown by Figs. 2 and 3. Some small catalogues are spaced so that the entire index can be made within the length of the pages, but for a catalogue like that of the Brown & Sharpe Mfg. Co., it must be arranged as follows: Index the length of the page, leaving a strip at the bottom to use as a holder for opening to the next set of indexed sheets, as indicated by A. Now, if what you wish to find is not on the first index, Fig. 2, place the thumb at A and open to the second index, shown in Fig. 3, and so on.



GRINDING TWIST DRILLS

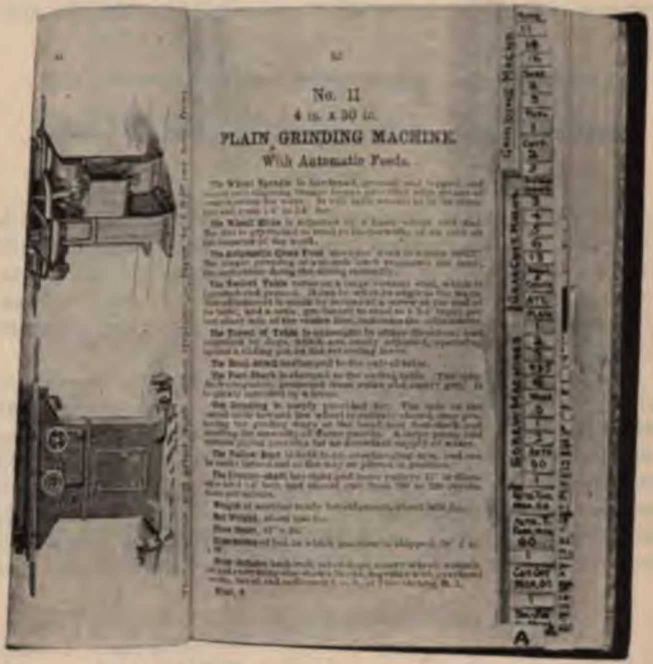
SPEED OF DRILLS.

Fig. 1 Illustrating Method of Indexing.



DIMENSIONS OF UNIVERSAL MILLING MACHINES.

Fig. 2, showing one of the Indices for a small Catalogue.



No. 11
4 in. x 30 in.
PLAIN GRINDING MACHINE.
With Automatic Feeds.

Fig. 3. Catalogue opened to Index "A" in Fig. 2.

If the catalogues should have a little more margin, the index could be made more complete. This scheme would hardly be practical except in cases where the catalogues were used very frequently for reference; and they are generally not of sufficient value to justify the expense of providing such an index on the part of those issuing the catalogues. EDWIN C. THURSTON.

Providence, R. I.

* * *

## TOOL CHESTS.

*Editor* MACHINERY:

All the different mechanics have, or think they should have, some kind of tool chest. The mason has an old sack; the plumber, a piece of Brussels carpet; the moulder will wrap his tools in an old shirt, if he has one; if not, he will put them in his hip pocket; a blacksmith will wrap his in a leather apron; the machinist, patternmaker, and carpenter, use a box or chest. All these different chests are made of a variety of material, and the workmanship is of all the different grades as best suits the individual taste and wealth of their proprietors. Some of these chests are fearfully and wonderfully made, while others are models of workmanship, neatness and design. The possession of a fine tool chest with its complement of fine tools does not, by any means, indicate a good mechanic; nor does the non-possession indicate any more, for we have all seen beautiful failures, with and without tools or chests. Now, I don't want to be understood as advocating the idea of trying to get along without the use of tools and a proper place to put them. Far from it, for these indicate methods and system, two very essential features of success. But above all this, a fine mechanic must have a good brain, and the man that has his tools in his head makes a hit with me, for he is always ready.

I saw, some time ago, what I considered a good example of this kind of mechanic. A young machinist had been sent by a prominent engine builder to investigate a high speed engine that had been giving trouble. After investigation it was found necessary to bore the cylinder, which he concluded to do in position. The engine was a 10 x 10 with an extra large piston and locomotive guides. He had a boring bar made at a neighboring machine shop, somewhat like Fig. 1, and of the proper dimensions. He then rigged up as shown in Fig. 2. The wood clamp, which was placed in the guides, formed the feed, the bar was a close fit for the stuffing box hole to give a bearing at the front end, and the wood bearing at the back end was made larger than the bar and when set in position was babbitted. The bar was turned by long cross handles in the holes at the extreme end. This rig, on short cylinders and under the management of a careful mechanic, will do very creditable work. Of course, the job required banding the piston head and refitting and a new set of rings. The machinist left this engine running in fine style, and all concerned felt very kindly toward him, and toward the company for sending a mechanic that did not "fall down."

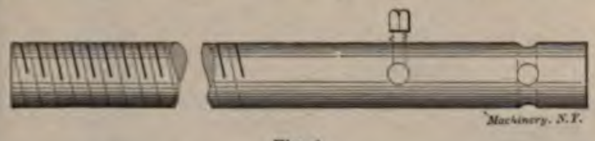


Fig. 1.

Another very remarkable case came under my observation while mechanically connected with a large insane asylum. An insane patient, speaking a foreign tongue, made all his tools and supplies (except leather) and did all the repairs on the boots and shoes for over five hundred men, and this without the aid of any one or the expenditure of a single cent. He maintained this for almost a year, when the management grew ashamed of their neglect and gave him a good kit of tools. From that time he lost all interest and could not be induced to work. He had made lasts, knives, plyers, shoe pegs, nails, wax ends, needles and everything he needed. His stock of leather was secured from old boots and shoes that he would gather in his wanderings about the place, but to look at his tools and then at his work this would seem impossible.

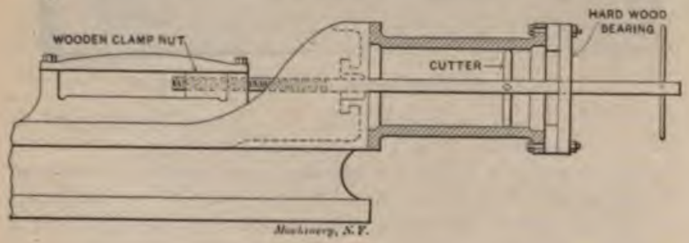


Fig. 2.

He also had a fad for making the numerous keys used about the institution, some of which were very difficult to make even for a good mechanic with good tools. I have seen as many as twenty keys taken from this man at one time and they were made so well that they were given to new employes. Of course, time "cut no ice" with him. This only illustrates the fact that if the tools are in the head, they can be had in reality.

CENTRAL WEST.

* * *

## AN EXPERIENCE OF A TOOL-BUILDING FIRM.

*Editor* MACHINERY:

The trials and vexatious occurrences that sometimes befall the lot of the machine tool builder, are usually not well calculated to sweeten his disposition or increase his respect for the mechanical abilities or good judgment of some superintendents and foremen of shops buying and using his tools. To illustrate I will relate a ludicrous occurrence which is said to have taken place in the works of a huge electrical concern.

They had ordered a small lathe from a well known tool building firm whose products are generally regarded with favor wherever used. The lathe was duly built and shipped to the concern after it had been thoroughly tried and tested in every particular. A few days after the shipment was made, a sharp telegram was received from the superintendent of the electrical concern, stating that the lathe was "N. G.," that the spindle gear lacked ¼" of meshing properly with the feed and screw cutting train, etc.

A competent machinist was immediately sent to the works of the electrical company and arrived just as the head-stock of the supposedly defective lathe was being set up on the planer to remove the superfluous amount from the under side which was thought to be necessary in order to let it down to the proper position. A halt in these proceedings was immediately called and a searching investigation of the lathe made. It was found that in pursuance of the general policy of examining all tools bought for the company, the lathe head-stock and apron had been taken apart to ascertain the condition of the bearings, after which tests were supposedly made to determine the condition of the machine as regards accuracy of alignment, although it is difficult to believe that these tests could have been carried out in an intelligent manner in the light of subsequent developments.

It was found that in some way during the examining process, the jaws of the head-stock embracing the back box of the spindle had been jammed on the side by some careless workman and that when the box was replaced, it did not seat within about ¼" of its true position. In this constrained condition the spindle had been run and attempts had been made to test it for alignment, etc. On account of the gears not meshing properly it had been concluded that the only way out of the difficulty was, as stated, to plane off the offending portion from the bottom of the head-stock.

What the status of a superintendent or foreman of machinists can be who would order or sanction any such remarkably foolish proceeding as this, is more than the writer can say, but he is assured that the facts as given here, are substantially correct.

Hoboken, N. J. R. P. PERRY.

* * *

## COMPOUNDING A SIMPLE LATHE.

*Editor* MACHINERY:

I was recently required to cut a triple screw, with pitch of 1" on a lathe with only two change gears, no other lathe being available. The lathe was indexed from 2 to 36, and in order to do the work I had to make a new stud to hold two more change gears, in place of the idler, moving the idler to another position.

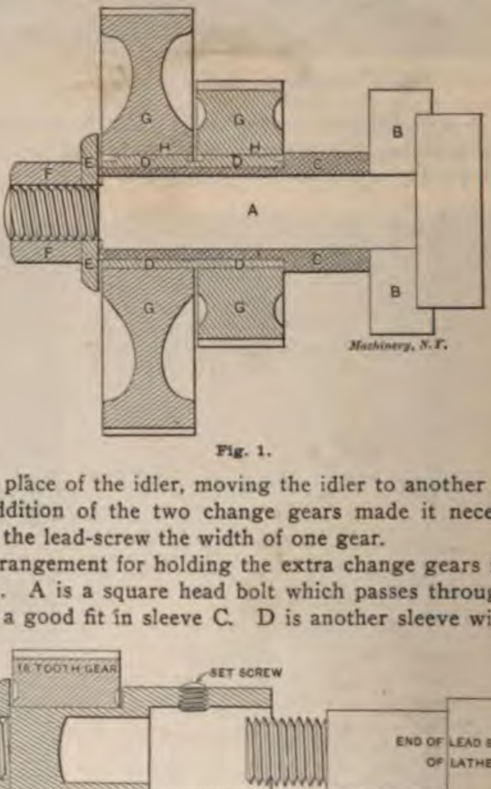


Fig. 1.

The addition of the two change gears made it necessary to lengthen the lead-screw the width of one gear.

The arrangement for holding the extra change gears is shown in Fig. 1. A is a square head bolt which passes through frame B and is a good fit in sleeve C. D is another sleeve with feathers, on which the gears are placed, and slipped over the sleeve C.

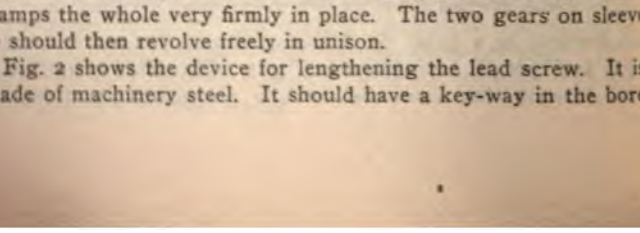


Fig. 2.

The sleeve D should be 1/32" shorter than the distance between the shoulder of sleeve C and the washer E. When the nut is screwed on, it forces the sleeve C against the frame B and clamps the whole very firmly in place. The two gears on sleeve D should then revolve freely in unison.

Fig. 2 shows the device for lengthening the lead screw. It is made of machinery steel. It should have a key-way in the bore and be an easy driving fit on end of screw. A set-screw helps to hold it in place. The end is turned to fit the hole in the gears and is supplied with a key, nut and washer.

Fig. 3 shows the arrangement for holding idler. A is a flat piece of machinery steel, drilled to receive the stud B, one end of which is turned to fit the hole in the gear, allowing same to revolve freely.

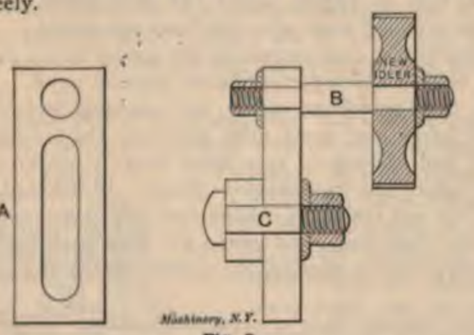


Fig. 3.

The piece is secured to the frame by means of a bolt C. The flat piece A is slotted to allow for adjustment.

Fig. 4 shows the extra change gears, A A' and the idler B in its new position. The lathe index called for 72-tooth gear on stud and 18-tooth gear on screw to cut 2 threads per inch. By using 2 to 1 (30 and 60) on the new stud, the lathe was geared to cut 1 thread per inch. I used a 48 gear for the idler, as it was the most convenient size.

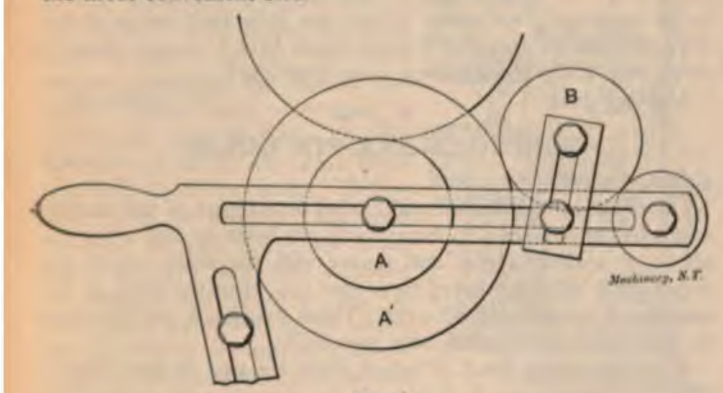


Fig. 4.

In order to cut the three threads evenly I scored a circle on face plate of lathe with a sharp pointed tool, and laid out and drilled very accurately three holes, to receive the dog, numbering them 1, 2 and 3. Starting at No. 1, I cut the three threads very handily.

These several devices cost very little to make and form a valuable addition to the equipment of the lathe.

Lancaster, N. Y. R. B. Casey.

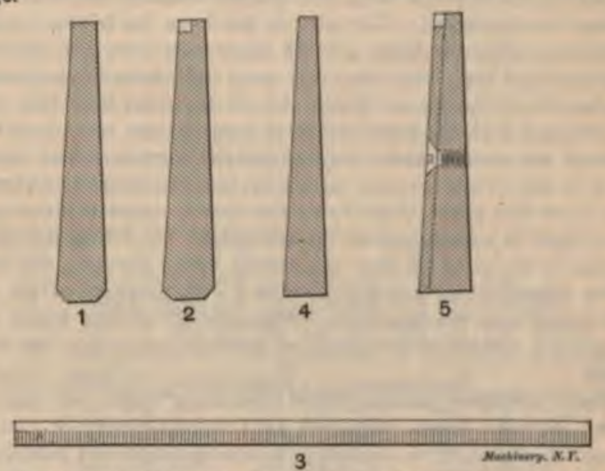
* * *

## KNIVES FOR CUTTING RUBBER, LEATHER, FIBER, ETC.

*Editor* Machinery:

If there is anything that dulls the edges of knives, it is cutting such material as sole leather, sheet packing, vulcanized fiber, etc. It might also be added that cork is troublesome to cut, but that if the knife be greased it will cut this about as a hot knife cuts butter. Water, soap suds, or better yet, a strong solution of potash may be used when cutting rubber.

If it be desired to cut out gaskets, or other forms which may be curved or irregular in outline, out of thick material, which makes a knife dull and the operator tired and profane, a pair of shears may be rigged up which cut with very little effort through stuff up to ½" thick. The entire trick is to keep the material from sliding or slipping before the advancing blades, and to prevent the upper blade from twisting it sidewise over the lower one. Naturally, the best way to prevent slipping is to roughen one of the surfaces on which the material tends to slide. We will assume that we have a stout short pair of shears that we wish to convert to the new system and take it for granted that the upper blade is the right-hand one. Grind the lower blade square across at right angles to the face against which the upper one works—having first drawn the temper. The section is now as in Fig. 1. Next, take a fine chisel and, just as though cutting the thin edge of a knife-edge file, make fine teeth in the upper edge, only leaving an uncut line along the edge of the working face, as shown in cross-section in Fig. 2 and in edge view in Fig. 3. The blade is now re-hardened and the cutting edge carefully ground and oil-stoned. The device is then assembled and will be found to cut through tough material with little effort. All the sharpening the lower blade will require is a little rubbing with an oiled Turkey stone, care being taken to leave no wire edge.



End and Edge Views of Knives for Cutting Sheet Material.

In some instances it may be more feasible to make the blade like Fig. 5. Draw the temper of the lower blade, grind it to the section shown in Fig. 4, drill and tap two screw holes and screw to it a separate thin blade, the upper edge of which has been filed or chisel-cut to form the teeth. Robert Grimshaw.

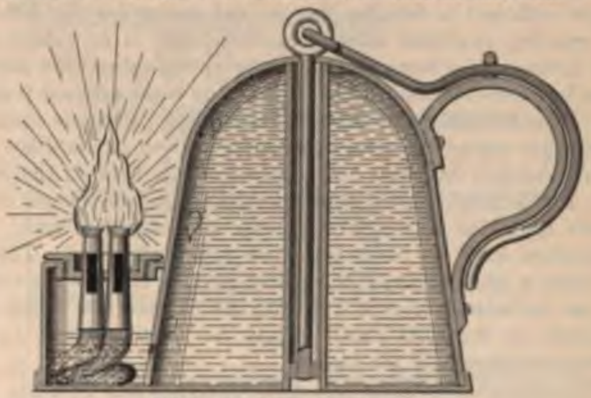
Paris, France.

* * *

## PNEUMATIC SELF-HEATING LAMP.

*Editor* Machinery:

One of the small things which tries the patience of the machinist in cold weather, is the congealing of the oil in his hand lamp, when it is most needed. Many pieces of work cost more than they should from this cause, and many have been ruined for the want of a good light. Considerable time and oil are lost in the effort to make them burn, and often the lamp is ruined by having the seams melted apart while thawing it over a fire. It is a common sight in winter time to see a half dozen men around a fire warming the oil in hand lamps, so that they will burn for a while. These lamps have often been consigned to a "warm place" by mechanics, but I hope St. Peter will not record this, as there are extenuating circumstances. As the writer does not wish to "hide his light under a bushel," he herewith presents a design of a hand lamp so that all may see.



Self-heating Lamp for the Shop.

It is self-heating, requires less attention than other lamps, and will burn from ten to fifteen hours with a good light. It will burn an inferior grade of oil, as the proximity of flame to the shell of the lamp keeps the oil warm and in a fluid state. It will keep the oil from congealing in the coldest weather and in the most exposed places. It does not require much capillary attraction to lift the oil to the flame, as the oil is always near the burner. In the ordinary hand lamp, the capillary attraction of the wick has a refining or separating influence upon the oil; that is, the finest qualities of the oil are filtered through the wick, as it offers the least resistance. They are consumed first, leaving a residuum of heavy oil, which clogs the pores of the capillary tubes in the wick that elevates the oil to the flame. Hence, a poor light with the lamp half full of oil, requiring constant refilling to get a good light. We soon have a lamp full of oil that the attraction of the wick is not strong enough to lift to the flame, and that is often thrown away for a fresh supply and new wick.

Most oils are adulterated, but this self-heating lamp will consume the adulterants. The wick is fed from the bottom of the reservoir, using the heavy oils or adulterants first, and the best quality of oil last, thus insuring a good light from the beginning to the end of the charge of oil. Under the most favorable conditions and with the best quality of lamp oil, the hand lamps in general use soon become dim, as the capillary attraction of the wick is not strong enough to elevate the oil any great distance, and from this cause alone twice the time is spent in keeping a good light in comparison to the self-heater. In filling this lamp it has to be tilted so that the burner space becomes the top, when placed in an upright position. The pressure of the air will retain it in the reservoir. When the oil is used below the opening, a bubble of air passes in, forcing the oil into the wick space.

There are other features about this lamp which will recommend its use. When employed as a hanging lamp, it can be turned to any point on its swivel, to accommodate the workman, and when not in use the hook can be stowed away around the handle and under the catch which forms a thumb hold. This lamp may cost more to manufacture than the others. It is like all other good things; it comes a little high, but the time and oil saved by this pneumatic self-heating lamp will make other lamps dear, even as a gift. GEO. C. STANLEY.

Norfolk, Va.

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## GASOLINE ENGINES.

*Editor* MACHINERY:

Some recent experiments on a form of gasoline engine in which an explosion is secured every revolution, while the Otto cycle is retained and there are no fake explosions, has brought into notice a little point of difficulty more or less common to all internal explosion engines. I refer to the premature explosions that sometimes take place in an apparently inexplicable manner. We discovered the existence of the fault in the above engine by accident, or at least inadvertently, for we switched off the electric igniter and the engine continued to run and explode.

Obviously there could be only one reason for this, namely, the incandescence of some internal part. Gas engines have long been known to be capable of running with no intentional means of ignition, and the cause has been found in the projection of a bolt head at the back of the piston. This projected into the compression space and became red hot, and in that state was found sufficient to fire the charge; and except for the difficulty of securing explosion exactly to time, there is no reason why the ignition tube flame should not be extinguished after the engine has been run long enough to heat up some internal projecting piece sufficiently to explode the charge. In some forms of petroleum engine the same principle is utilized in the shape of a narrow-necked cast-iron bottle bolted to the back of the cylinder, and so proportioned as to its capacity and the length of the bottle neck that explosion will occur at the correct time. The explosions keep the bottle in a state of incandescence. The petroleum is sprayed upon its internal surface and the air charge in the cylinder is driven from the piston into the bottle and explodes at the right time, because the air then forms an explosive mixture with the vapor.

The difficulties experienced with this form are several. The cast-iron bottle requires to be renewed from time to time, because it becomes very rotten with heat and finally is ruptured. Secondly, if the load on the engine is very light, the engine is apt to refuse to work at all. This is because the amount of oil burned is not sufficient to maintain the bottle incandescent, and it fails to explode the mixture or to sufficiently vaporize the charge. When it was not possible to procure petroleum engines of a power small enough for their intended duty—engines of 3 H. P. being about the smallest to be obtained at the time I have in mind—this trouble involved complete remodeling of the bottle or vaporizer by casting additional ribs in it and by protecting it from loss of heat, so as to maintain its incandescence. But there was a great tendency amongst the men sent out to put up and start engines to arrange a convenient plank brake against the flywheel whereby, of course, the work was increased and the vaporizer kept warm. Very slight differences of surroundings would enable an engine to run or cause it to stop when under light load with a cold vaporizer. On one occasion we found that an engine would run with closed engine room doors, but stopped soon after the door was opened. The cause was obviously the cool current of air acting at the critical temperature to cool the vaporizer below ignition point.

In one little petroleum motor, the sparking device projecting from the back head some little way into the cylinder became very hot, and, though of very small bulk, it proved quite sufficient to ignite the compressed charge. It did not, however, produce any evil result, as it happened to produce explosion exactly at the right time, and would not have been found out had we not happened to shut off the spark and the engine ran merrily on.

Gasoline engines have a certain advantage in the fact that their explosive mixture enters the cylinder very cold, and suitable direction may be made to chill off this igniter, if desired, prior to the compression attaining the intensity of explosion. Though a small matter, it is one that may, perhaps, be usefully known to some who have not had cause to suspect its existence. Automobile work is so novel, and there is so much to be found out. I have known one little fault, which might have been effectually cured by a few minutes' work with a smooth file, to be the cause of a five month's delay. Anything and everything seemed to be reasonably suspected except the little fault really at the bottom of all the trouble. But doubtless here I am preaching to many who know these things from experience.

London, Eng. W. H. BOOTH.

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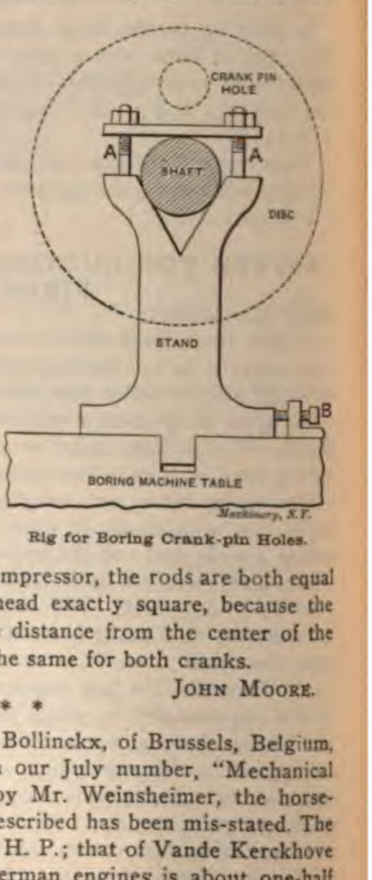
## BORING CRANK-PIN HOLES.

*Editor* MACHINERY:

I herewith give a sketch and a brief description of the method employed in our shop to bore crank-pin holes so that they will all be of uniform throw and square with the shaft. First, the crank shaft holes are bored to proper size, then the discs or fly-wheels are roughed off all over. These fly-wheels and discs are for air compressors that I have seen built.

A sketch of the stand, of which there are two, is here shown. There are two studs, A A in each, for clamping the crank shaft into the vees. The machine has a slot in the center of the table, parallel with the spindle, in which the tongues of the stands go. A set-screw B is provided, which forces the tongue of each V-stand against one side of the slot, so that the stands always come exactly in line. The table can be raised or lowered so as to bore the crank-pin-holes to any throw. If the machine is marked, you always get the same throw without measuring each time. This way of doing the work brings the holes exactly in line with the crank shaft in all directions, so that when they are on the compressor, the rods are both equal in length, and pull the cross head exactly square, because the center of both pins is the same distance from the center of the shaft, the throw being exactly the same for both cranks.



Rig for Boring Crank-pin Holes.

JOHN MOORE.

* * *

We are informed by Mr. H. Bollinckx, of Brussels, Belgium, that in the article published in our July number, "Mechanical Features of the Exposition," by Mr. Weinsheimer, the horsepower of some of the engines described has been mis-stated. The engine of Carels Freres is 1,500 H. P.; that of Vande Kerckhove of 1,200. The power of the German engines is about one-half that stated in the article.

# EPICYCLIC GEARING.—3.

## APPLICATIONS IN BEVEL GEARING.

The epicyclic bevel gear train, such as is shown in its elementary form in Fig. 1, possesses properties that are both interesting and useful. There are five parts in Fig. 1, the shaft, the arm K, upon which turns the intermediate bevel pinion B, and the main bevel gears A and C which are in mesh with pinion B. There are several conditions that can exist with a tran of this description.

First, suppose gear A to be stationary and C to be loose on the shaft. If the shaft and the arm K turn, carrying the intermediate pinion B with them, C will make two turns for every one of the arm. Also, if A, instead of being stationary, should itself rotate, this motion, combined with that of the arm, would modify the motion of the last gear C, and it would also make a difference whether the first gear turned in the same or opposite direction as the arm.

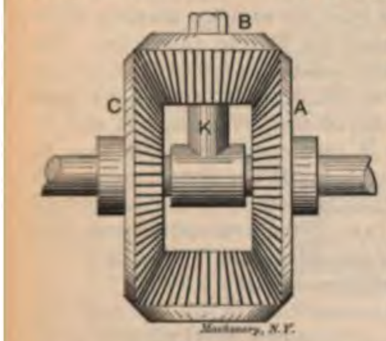


Fig. 1.

Second, suppose the above condition to be reversed, and one of the bevel gears A or C to be driven, while the other is stationary; or both to be driven, while the arm K, which carries the bevel pinion constitutes the driven element. Where only one gear is driven, the arm will turn in the direction in which the gear turns and with half its speed. Where both gears are driven in the same direction, the arm will follow in the same direction and with a speed intermediate between the two. If both gears are driven in the opposite directions, the arm will follow in the direction of the more rapidly moving gear.

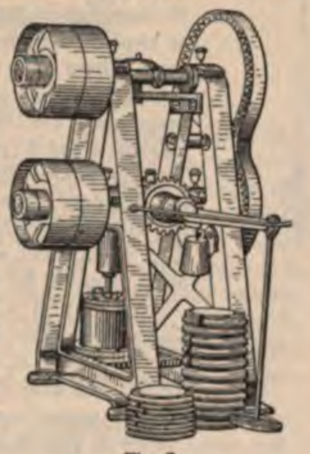


Fig. 2.

Third, suppose arm K to be fixed and A and C loose on the shaft. If A is the driver, the pinion B will simply transmit motion to gear C, and the force tending to rotate the arm K will be just one-half the force transmitted from A to C.

An application of this last principle is found in the familiar Webber differential dynamometer, shown in Fig. 2. The arm of this dynamometer, which supports the scale pan, also carries two bevel pinions corresponding to pinion B in Fig. 1. This arm pivots on a shaft upon which are two bevel gears in mesh with the pinion mentioned, like gears A and C in Fig. 1, and power is transmitted through this train of gearing, the amount of power being measured by the weights in the scale pan.

In the May number of this paper, in an article upon the application of the epicyclic principle to spur gearing, reference was made to an ingenious crank motion that was used by Chas. E. Barrett, a New England mechanic. Ten or fifteen years ago Mr. Barrett had another device, of which he made a model, and while it was of little practical value, the model excited the wonder of those who saw it operate, but were not initiated into the secrets of its "modus operandi."

All that was visible was a long box, through which apparently ran a straight shaft from end to end. On one end of the shaft was a crank and on the other end, apparently, a wheel. Upon turning the crank, however, the wheel would make several times as many rotations as the crank, and the reason for this unexpected performance was to many a mystery. The secret of the model is shown in Fig. 3, and while it does not correctly indicate the details of construction, it will serve to illustrate the principle. There are three sets of gears, marked 1, 2 and 3, respectively, and four bearings marked 4, 5, 6 and 7, for supporting the gears and their shafts. Starting at the right in the illustration, the handle is pinned to a short shaft passing through bearing 7 and on the other end of which is a hub, K, with two arms, on which the gears, B, B, turn. The gear, A, meshes with gears B, B, and is fast to the frame, so that it cannot turn. Gear C meshes with gears B B, and is pinned to a short shaft turning in bearing 6, and on the other end of which is another double arm K′, with its set of gears in all respects like K and its gears. One turn of the handle causes K and gears B B to rotate about the axis x y, and gears B B also have a rotation about their own axes because of their contact with gear A. The result is that gear C will make two turns, or twice as many as arm K. In the same way gear C′ will make twice as many turns as gear C, or four turns, and the last gear, C″, will turn eight times, as will also the flywheel, which is connected with gear C″. One turn of the handle, therefore, will cause the flywheel to turn eight times, and if there were another set of bevel gears the flywheel would turn sixteen times, and so on.

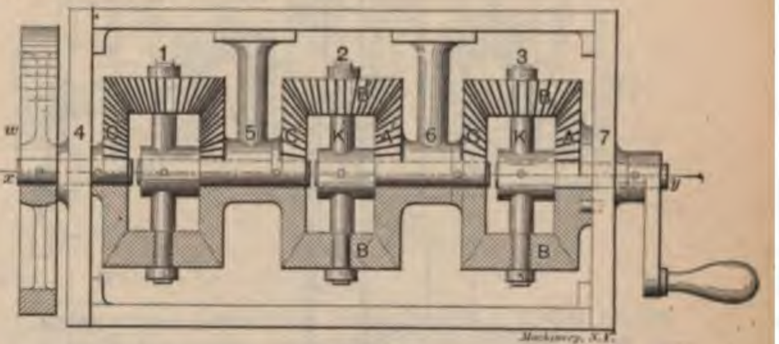


Fig. 3.

While this may not be very practical mechanism, it illustrates nicely the first principle enumerated above. A further illustration of the same principle, though somewhat more complicated in its action, is the so-called compensating gears of automobiles. One of these, as adopted by the Riker Motor Vehicle Co., is sketched in Fig. 4. The gears are placed in the hub of one of the rear wheels, and so connect the rear or driving wheels with the motor that either wheel can move faster or slower than the other, to accommodate the curves or irregularities of the road over which the carriage travels. The motor drives the sleeve D, from which the two wheels of the vehicle are driven indirectly through the gearing in one of the hubs. The sleeve carries a frame B, which supports the pins upon which the two intermediate bevel pinions turn. Gear A, which meshes with these pinions, is keyed to the shaft S, at the right end of which is keyed the hub of one of the carriage wheels. Gear C, which also meshes with the pinions, is keyed to the hub H of the other wheel. The two wheels are thus connected to the driving power through the intermediate pinions, the frame B and the sleeve D. The result is, that while the pinions may be driven about the axis of the shaft S at a constant speed, either wheel is free to turn alone or at a different speed from the other, according to the resistance that it must overcome. The compensating gear of the Riker vehicles is of neat design and makes it unnecessary to have the shaft in two parts, as is sometimes the case.

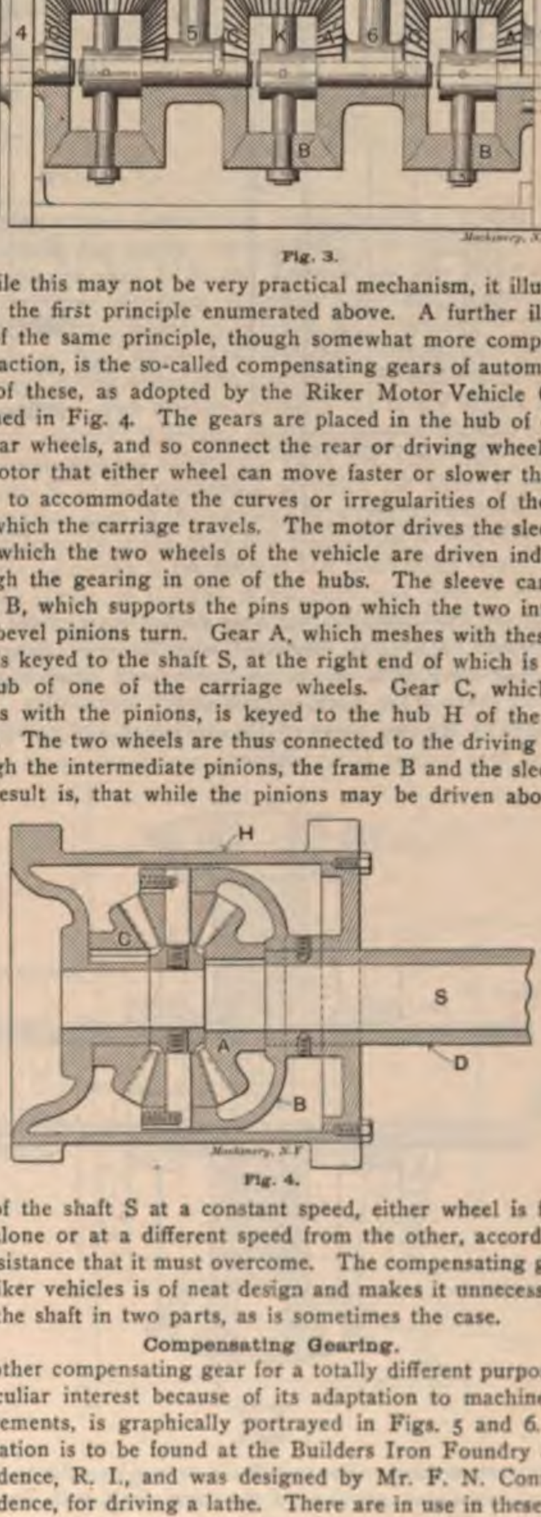


Fig. 4.

### Compensating Gearing.

Another compensating gear for a totally different purpose, but of peculiar interest because of its adaptation to machine shop requirements, is graphically portrayed in Figs. 5 and 6. This application is to be found at the Builders Iron Foundry Shops, Providence, R. I., and was designed by Mr. F. N. Connet, of Providence, for driving a lathe. There are in use in these shops two old lathes that served their country in the manufacture of ordnance for the civil war, and have since faithfully done their duty in a great variety of operations. One of these has been built over with an extra headstock at the "tail" end of the bed and the spindle of this headstock is driven by a pair of worms and a worm-wheel. A rope drive of peculiar construction is employed for transmitting power from the countershaft to the worms, and the compensating gear alluded to is placed on the countershaft, and is so connected with the rope sheaves that the ropes drive each worm uniformly and cause it in turn to do its share of the work, in spite of any inequalities.

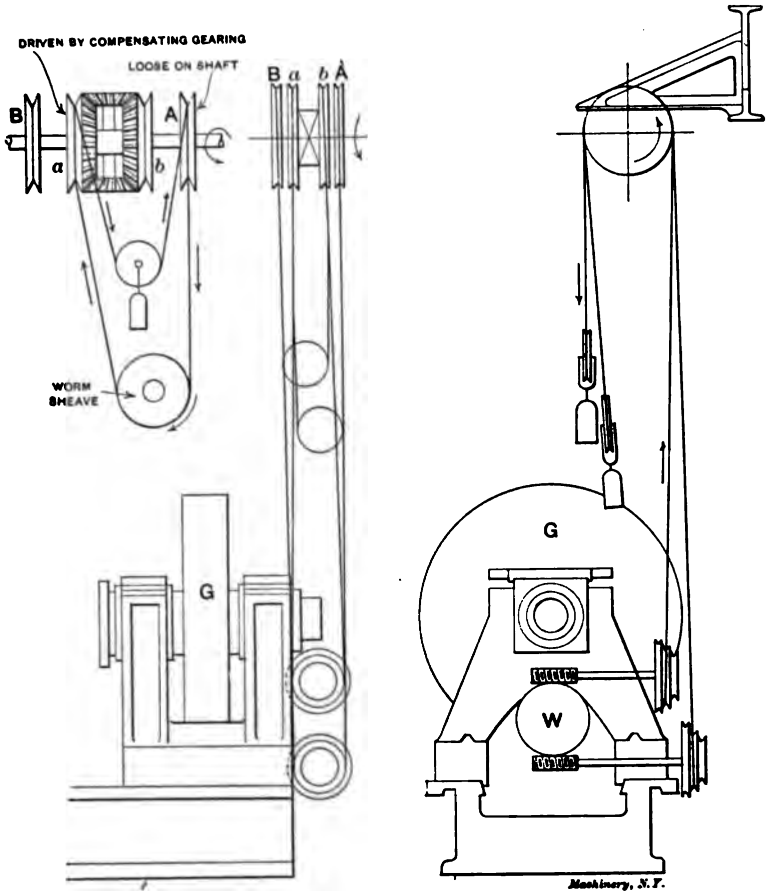


Fig. 5.

In Fig. 5 are two views of the headstock and countershaft, with the rope drive. The spindle is driven by a large internal gear, G, through a pinion on the same shaft with the worm-wheel W. The worm shafts have three-stepped sheaves and the countershaft above is suspended from a bracket attached to an I-beam. There are four sheaves on the countershaft labeled a, A, b and B. Sheaves A and B are loose on the shaft, while a and b are flexibly connected to it through the compensating gearing. A separate rope is used to drive each worm, and the tension of the ropes is maintained by weights suspended from pulleys, as indicated, one of which is represented as hanging at an angle for the sake of clearness in the illustration. The course of the ropes can be followed by the aid of the diagram in the upper left-hand corner of Fig. 5. Sheave a is the driver, while A, which is loose, simply guides the rope back to the worm sheave after it has left the weight pulley. For driving the other worm, sheaves b and B are used in a similar manner, b being the driver.

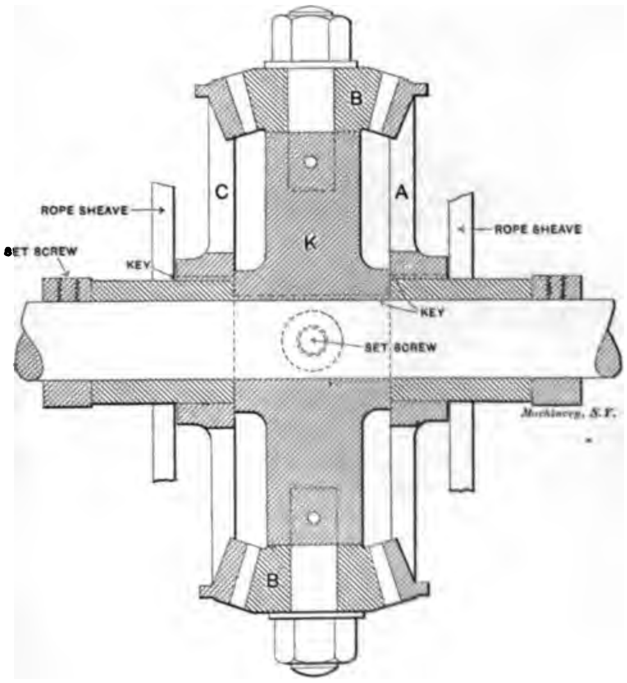


Fig. 6.

Fig. 6 is reproduced from the working drawing of the compensating gear used for driving this lathe. The arms of the two sheaves, which are lettered a and b in Fig. 5, are indicated in the drawing; and to the hubs of these sheaves are keyed the bevel gears A and C. The bevel pinions, B B, turn upon pins in the arm K, which rotates with the shaft. If one sheave meets with a greater resistance than the other, it will fall behind the other, as in the case of the automobile gear, and automatically equalize the work done by the two.

**Illustrations of Case 2.**

In the three last examples cited it will be noted that the arm carrying the intermediate bevel pinions is the driver, while the two main bevel gears, or at least one of them, constitute the driven elements, substantially as explained under case 1 at the beginning. In most cases where this mechanism is applied, however, the arrangement is reversed and one or both of the two main gears are the drivers, while the arm carrying the pinions is the driven element.

An ingenious illustration of this is also to be found at the Builders' Iron Foundry, in the operating mechanism of the electric cranes in the foundry department. This mechanism was designed by Mr. Connet and has been patented by him.

In Fig. 7 is a general view of one of the cranes. There are two chains attached to the crane hook, one of which, A, passes up and over a pulley on the trolley, and over pulley 1 to the winding drum C. The other chain, A', passes upward over its trolley pulley, to the left, over pulley 2, and finally over pulley 1' to a drum located back of the drum C. The chains are made to wind upon their respective drums in opposite directions, and it is clear that if both drums be rotated in opposite directions, at the same speed, the effect will be simply to raise or lower the hoisting hook; while if the drums rotate in the same direction and at equal speeds, the chain will be taken in by one and slacked off by the other, while the hook and its load will be carried horizontally without raising or lowering. Any difference in the speed of the two drums, when moving either in the same or opposite directions, will evidently cause the hook to move both vertically and horizontally at the same time. The mechanism operating the two drums is shown in Fig. 8. There are two electric motors, M and N, one of which, N, drives the spur gears, G G, and with them, the bevel gears A A, of the two epicyclic bevel gear trains in the same direction. The other motor, M, drives the worm wheels, H H, in opposite directions, and with them the bevel gears C. C. The intermediate pinions of these trains revolve on the arms K K, which are keyed to the shafts of their respective drums, and the gears A, A, and C, C, are loose on their shafts.

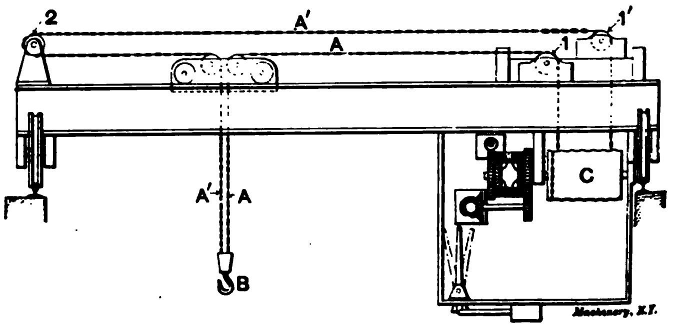


Fig. 7

It will be evident that with motor N stationary, motor M will drive the drums in opposite directions, and so raise or lower the hook, as explained above. With M stationary, motor N will operate the drums in the same direction, and move the hook horizontally. As the motors can be reversed, or operated together at varying speeds, any desired combination of movements and speeds for the crane hook and its load can be obtained. The actions of these trains of gears is entirely similar to that of the others that have been explained in the previous illustrations.

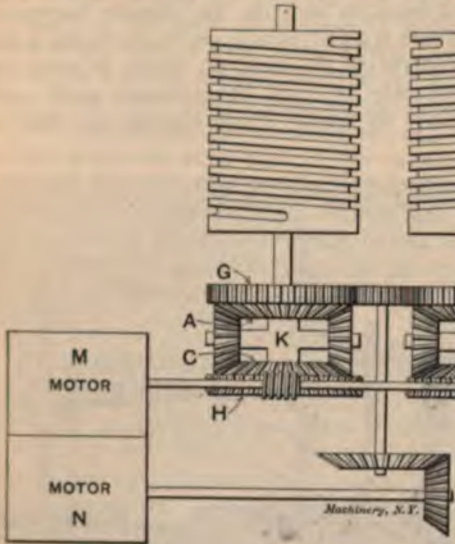


Fig. 8.

### Water-wheel Governing.

The works of the Simonds Mfg. Co., Fitchburg, Mass., are operated by electric power, generated at a small station, in which the generators are driven by water power. The governing arrangement used at this station is simple and effective, and is shown in principle in Fig. 9. There is an auxiliary water motor which drives the bevel gear A by the belt D, while gear C is driven by belt E from a shaft operated by the main turbine. Both gears A and C are loose on their shaft, but the arm K, which carries gears B, B, is fast to the shaft. On the end of the shaft is a pinion, which gears in the rack that operates the turbine gate. The auxiliary motor, having no work to do except to drive its share of the gate-operating mechanism, runs at practically a constant speed, varying only with a rise or fall of the water level above the dam, which would be a small percentage of the total head of water. It may be assumed that this motor will run at a constant speed, and so the speed of gear A is practically uniform. The speed of gear C, however, changes with an increase or decrease of the load upon the turbine, and as it runs faster or slower than wheel A, the arm K follows it around one way or the other, as the case may be, and opens or closes the turbine gate, as required.

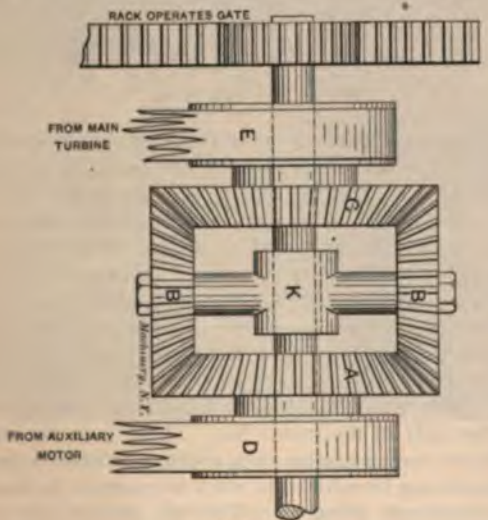


Fig. 9.

By way of contrast, in point of size of plant, it will be of interest to refer to another water-wheel governor, which, although entirely different, has epicyclic gearing operating on the same principle as the governor at the Simonds plant. This is the Faesch and Piccard governor, of Geneva, Switzerland, as used at the immense plant of the Niagara Falls Power Co. In this case there are two sets of epicyclic gearing, marked M and N, respectively, in Fig. 10. In each of these the gears A and C are loose on the shaft, as in the preceding case, but gears A, A', instead of being driven from without, are simply allowed to turn freely on the shaft with the arm K, or are kept from turning by the brake bands O, O'. The inside wheels C, C', are driven, one by a crossed belt and one by an open belt, from some source of power operated by the turbine. The brake bands are so arranged that when one tightens the other loosens its grip on its pulley. Both these bands are actuated by the shaft L, and the tightening of the bands takes place through a double ratchet mechanism, not shown, having two actuating pawls, one of which rotates shaft L in one direction and the other actuates it in the other direction. There is a fly-ball governor driven from the turbine, the duties of which are to put one or the other of the pawls into action when the speed increases or decreases. The result is that under such conditions one brake band is tightened and the other released, causing one of the wheels marked A to be held with a greater or less degree of friction, or to be kept from turning altogether, while the other one runs free. The arm K of the mechanism in which the wheel is held fast will begin to turn in the direction in which the wheel C turns—in one direction if the open-belt mechanism is operating and in the other direction if the crossed belt mechanism is operating—and the pinion on the end of the shaft will raise or lower the gate. This is a powerful governor, depending for its sensitiveness upon a regular fly-ball governor and for its power upon a belt which can transmit any desired amount of power.

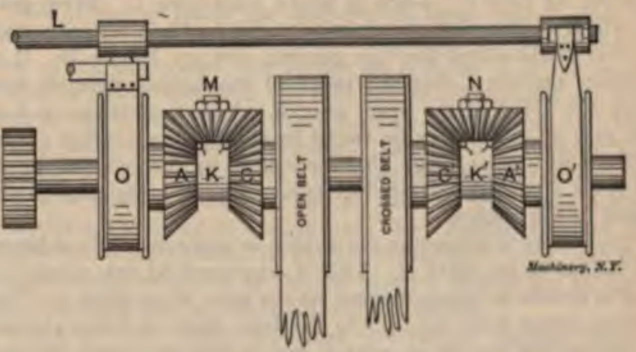


Fig. 10.

### Cotton Spinning.

As a final illustration of epicyclic bevel gearing, there is shown in Fig. 11 an example of the differential motion used in cotton spinning. During the process of manufacture, the untwisted fiber, or roving, as it is called, is drawn out or attenuated by passing between successive pairs of rolls, which move, successively, at increased speeds. The fiber is then wound on bobbins

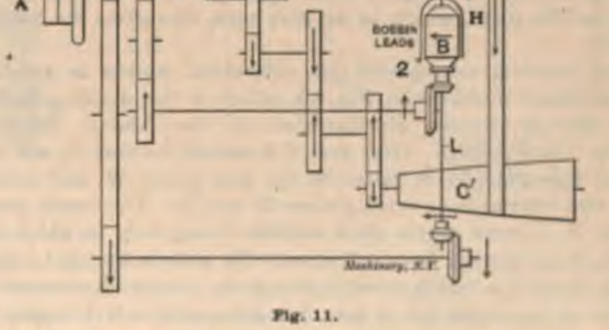


Fig. 11.

and at the same time given a slight twist. In Fig. 11 are the outlines of a "fly frame," designed for attenuating and twisting the fiber and winding it on bobbins.

Power is received by the pulley A, and is transmitted through the shaft S and the train of gears shown, to the cone C and the rolls, one of which is at the upper part of the diagram. The cone C and the rolls move at a constant speed and the roving is delivered by the rolls at a uniform rate of speed. On the shaft S is a bevel gear E, which is one of an epicyclic bevel gear train called in this case the "differential motion." The large gear D constitutes the arm of the train, since it carries the two intermediate bevel pinions, and is driven through a train of gearing by cone C', which is belted from cone C. Bevel gear F, which meshes with the pinions carried by D, is loose on shaft S, and is connected through gearing with the bobbin B. It is evident, therefore, that the speed of the bobbin depends first upon the speed of the bevel gear E, which is constant, and of the gear D, which may be varied by shifting the position of the belt on the cones. Any slight variation in the relative speeds of gears E and D will produce twice as great a variation in the speed of the bobbin.

The roving is wound on the bobbin in successive helical layers by means of the flyer H. This is supported by the spindle L, and is driven at constant speed by the gear M on shaft S. The roving passes from the rolls to the flyer, where it enters the top of the hollow spindle at point 1, and is threaded down through the left-hand arm of the flyer to point 2, where it emerges and goes to the bobbin. The bobbin rotates faster than the flyer, in this way laying on the successive coils, and as each coil is added the flyer travels up and down, so as to cover the whole bobbin with successive layers. As the layers are added, the bobbin increases in diameter and its speed relative to that of the flyer must be decreased, to prevent breaking the roving. This is accomplished through the differential motion by shifting the belt on the cones, which, as we have seen, also alters the bobbin speed.

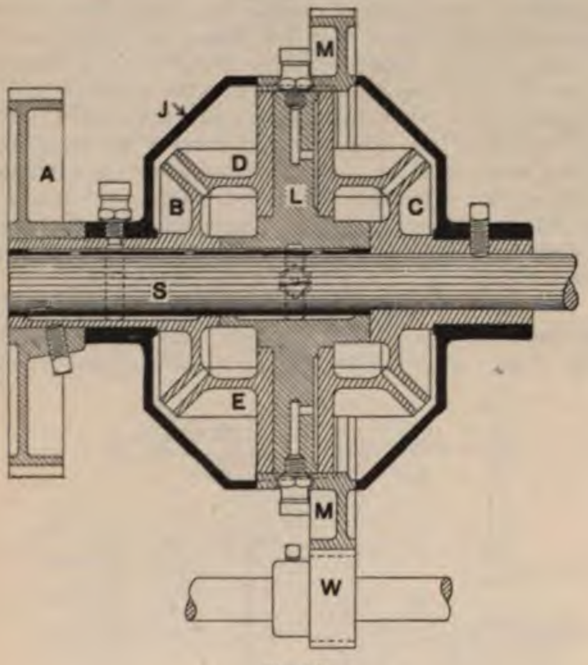


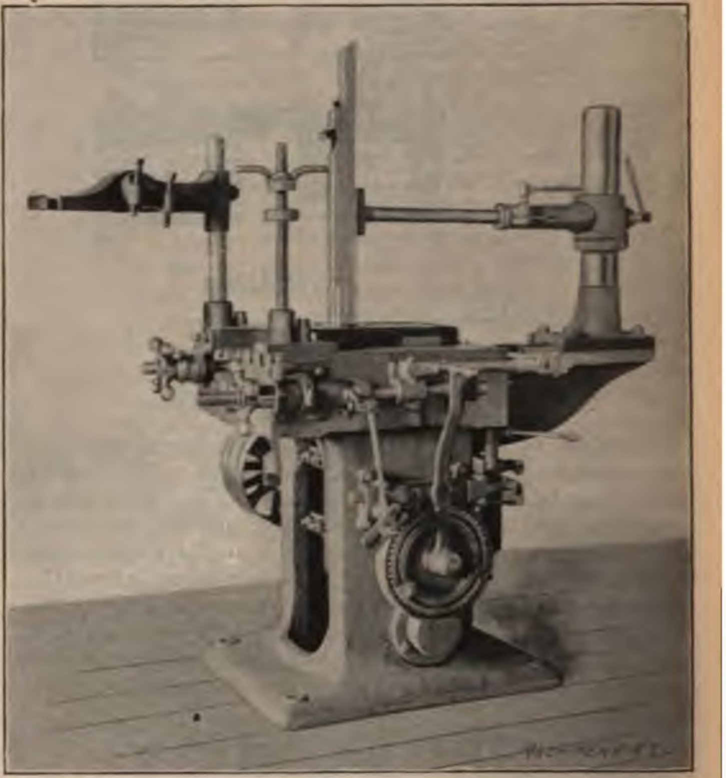
Fig. 12.

An excellent example of this differential motion as actually constructed is shown in Fig. 12, which is the design adopted for the fly frames manufactured by the Lowell Machine Shop, Lowell, Mass. Here gear C is fast to the shaft S, and the large spur gear, M, is driven by the spur pinion W, and carries the two intermediate bevel pinions E and D. The fourth bevel gear, B, is loose on the shaft and has a long hub, to which the gear A is fastened by a set screw. To protect the parts from dust, there is a casing made in two parts, lettered J, one-half of which is fast to the hub of gear B and the other is fast to gear C. The parts that turn loosely on the shaft S are bushed with a composition liner and ample oil grooves are provided as indicated. This design is admirable, and is well worthy the study of any one who has to design an epicyclic bevel gear train.

## NEW KEY-WAY CUTTER.

The accompanying illustration is of one of the Morton 20-inch stroke, standard key-way cutters, which embodies new and novel features. The construction is of the box column form, the column being heavily ribbed. The table is tongued and grooved and bolted to the top of the column, and is unusually heavy, so as to support the heaviest class of work when necessary.

The cutter bar is driven by a steel rack and steel pinion and the rack is located centrally with the bar, thereby overcoming any side strain. There is an adjustable guide that forms a bearing immediately underneath the table, no matter in what position the cross-head may be, and an extension guide which forms a bearing above the work. These bearings are rigid and easily adjusted.



Morton Key-way Cutter.

The machine gets its reciprocatory motion by the employment of open and cross belts, and has a quick return of three to one. The belt shifting is of such design as to throw the driving belt entirely from the tight pulley before the driver is shifted on and the special construction is such that the countershaft may be easily placed on the floor at the rear of the machine, or can be placed at an angle of 45 degrees or directly above the machine.

The stroke is adjusted by means of tappets on a circular disc and there is a reverse lever, whereby the motion of the cutter bar can be reversed at any part of its stroke. There is an auxiliary plate on top of the table, supplied with jaws which come up on either side of the cutter bar. These jaws are adjustable to the different sizes of cutter bars, and projections on them form a centering device by which the work is centered by the bore of the wheel or pinion being cut. This top plate is also provided with a micrometer adjustment, so that the machine may be set to cut key-seats of the given depth without the use of a rule. The taper and depth are all controlled by the feed hand-wheel, the graduations for taper being shown on the side of the top plate. It will plane taper either way. The machine is stopped and started instantly by means of a friction clutch provided with an automatic friction feed.

The cutter bars are flat and made of crucible, hammered steel. When worn on the back side, they can be planed and re-fitted at a slight expense. The smallest sizes of bars are fitted into a special chuck, by which they can be easily and quickly removed from the machine. The cutters are made on such a degree of angle as to cause the machine to take its cut without placing any more strain than is absolutely necessary on the working portions of the machine. The cutter bar is provided with an automatic relief for the return stroke. The machine can be fed automatically in key-ways of any width, and when it comes up to the required depth the stop collar located on the feed screw makes the friction feed slip so that it is impossible for the machine to cut a key-seat any deeper than the automatic feed will allow it. This is a very desirable feature when key-seating steel and other work, as it leaves the operator entirely free to lubricate and attend to the cutter.

The special construction of the feed and other actuating mechanisms of this machine are such that the work remains stationary or fixed on the table, there being no sliding or other bearings which are liable to wear and lose their alignment when subjected to the strain of a heavy wheel placed upon the table.

There is an improved rapid-binding attachment by which one screw will successfully secure the work, and with it pieces of couplings, gears and other work of this nature can be very rapidly placed. The table is also provided with T-slots for securing the work which the binder is not adapted for.

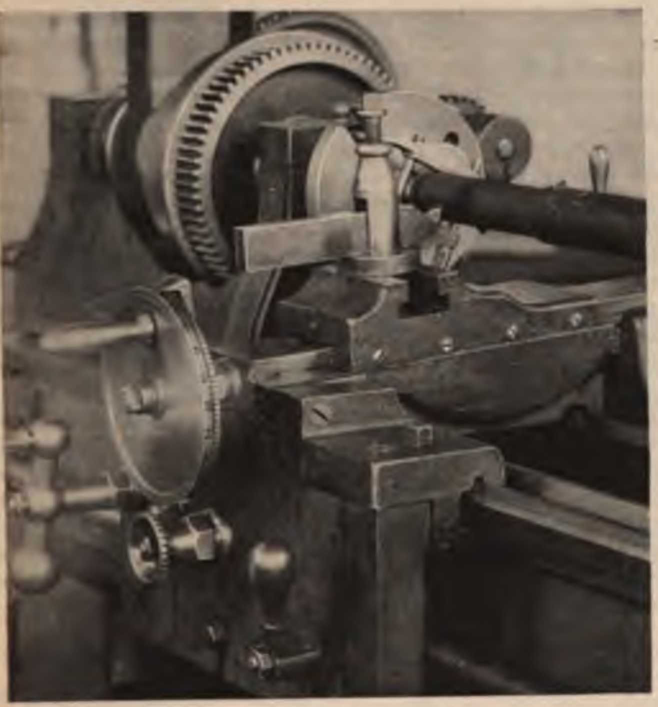
This machine is designed and built by the Morton Mfg. Co. at Muskegon Heights, Mich., who have given their special attention to the development and construction of key-seating machinery.

* * *

## A CONVENIENT ATTACHMENT.

As our readers know, J. T. Slocomb & Co., Providence R. I., have made a specialty for a number of years of micrometer calipers for shop use. These calipers range in sizes from one to six inches, and are intended to be employed by workmen in their every-day operations.

To facilitate accurate work in the shop and convenience in obtaining sizes, J. T. Slocomb & Co. have used index dials on the cross-feed screw of their lathes similar to the one shown in the accompanying illustration. They have kindly furnished us with particulars about their construction and use, which we publish herewith:



Dial for Micrometric Measurements.

"In fitting these dials to our lathes, we fitted the disc in the place of the usual ball crank. We turned a straight fit on the quill extending from the lathe apron and fitted to it the pointer, which is split and held by a binding screw. Our original intentions were to shift this point so as to start from even divisions, but we found, in use, that this is unnecessary. These dials greatly simplify some parts of the machinist business, when used in connection with micrometer calipers. We turn sizes for accurate fits by the most straightforward methods possible. There are no "cut and try" methods about it—simply round up the work and measure it with the micrometer, which shows how many thousandths there are remaining to come off; then by the reading on the dial the cutting tool can be adjusted to take off this remainder. There is in this case little chance for mistake and a great saving in time over the more ancient way.

"Although the most valuable feature of these graduated dials is in adjusting for sizes, still there are other uses. We use them exclusively for cutting threads instead of the usual screw-cutting stop, and find the advantage that the depths of cuts are accurately measured. Every one knows that most screw-cutting stops spring so badly that fine finishing cuts are difficult. As an example, in cutting, say 7/16" 14-P threads on short work, start in by taking .005 to each cut for about 6 cuts, then take .003 for 5 or 6 more, then finish by taking .001 or .002. as is required to make smooth threads.

"This is not so much like guessing as usual, and it gives a person a clear understanding of what the work will stand. Every piece of the same kind can be cut by running over the same number of times and until the tool has to be changed all will finish to exact size by the same reading on the dial, and the starting point will also be the same. The dial is also useful for adjusting for turning tapers. For testing truth of work by using a suitable tool, the dial can be made to show how many thousandths the work is out of true. For cutting recesses in inside work, places difficult to get at to measure, the tool can be adjusted to the same size on the end of work easy to get at, and then other sizes can be adjusted for it by the dial.

"There are also other uses that will readily suggest themselves to suit the work in hand. Of course, it is to be understood that a little judgment is required in handling. The feed screws on most machine tools are not very accurate, varying in inaccuracy up to as high as .006 to the inch, and so it would not be safe to place confidence in dial readings for long adjustments, when accuracy is required; and there is no occasion for this, as a general thing, for short readings will answer the purpose. Also it should be understood that some experience is necessary before the best results can be obtained.

"Of course, the dial must be graduated to suit the pitch of the feed screw. For an 8-P screw we use a dial 5 inches in diameter graduated in 125 divisions, in short lines, for thousandths. With every 5th line extended and numbered we also graduate one division on the pointer in ¼ thousandths, so one of these short divisions on the pointer reduces the diameter of the work ½ thousandths."

* * *

## BRAINARD GEAR CUTTER.

There is no piece of work requiring more care than making index or dividing wheels for gear cutting machines and there is no mechanism to be found on machine tools of greater interest than that devised to automatically space the gear blank on which teeth are being automatically cut. The accompanying illustrations are from working drawings of the spacing device used on the gear cutters made by the Becker-Brainard Milling Machine Co., Hyde Park, Mass., who have kindly furnished the following description of the arrangement as well as of their method of making an accurate dividing wheel.

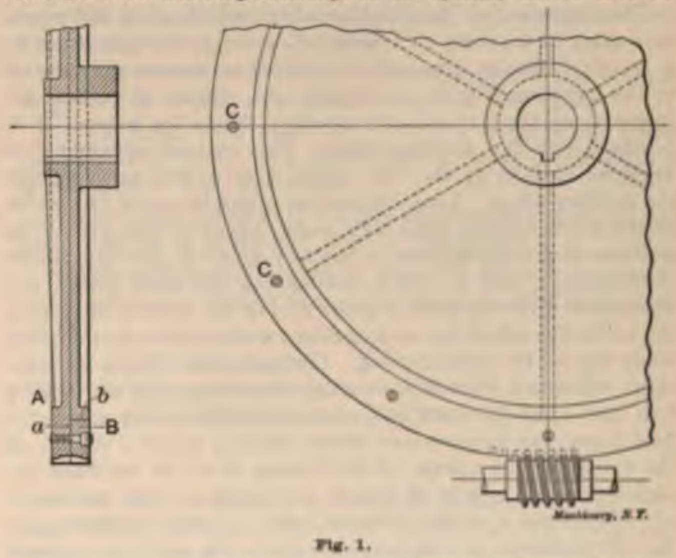


Fig. 1.

The essential feature of the mechanism is the worm wheel shown in Fig. 1. This wheel is built in two parts, the line of division being in the center of the rim, thus splitting the teeth equally. One of these parts is the wheel proper (A), the other is a ring (B) let into the wheel so as to form half of the rim. The ring (B) is carefully turned, and the face (a) trued up on a face plate by scraping in the usual manner. The surfaces (a) and (b) are then accurately fitted into the wheel. The next step toward completion is the drilling and tapping of the holes (C). These holes must be so spaced that when the ring (B) is turned to bring one hole above any other in the wheel (A) all the holes exactly coincide. Ring and wheel are now clamped together by the twelve machine screws, and the process of cutting the teeth begins.

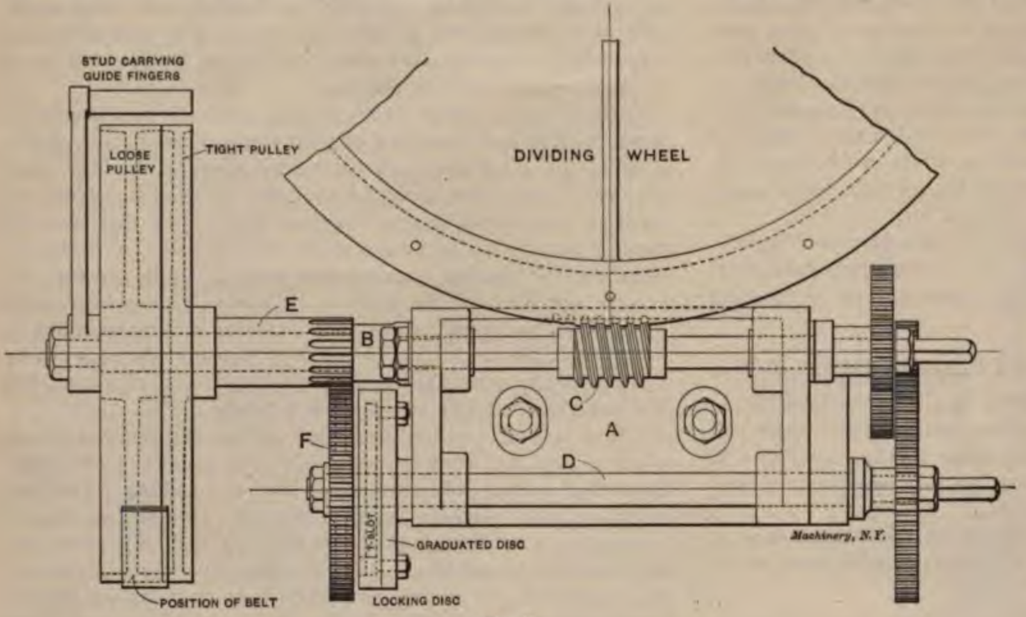


Fig. 2.

A single cutter first roughs out the teeth—180 on a 36" gear cutter—leaving sufficient stock for the several finishing cuts taken by the hob, a cutter with teeth set on the same spiral as the worm which is to drive the wheel. The ring (B) is now turned around several spaces (six, for example, on the wheel A), is again secured to the wheel and a second cut taken. This process is repeated until a given hole in the ring has covered every other hole in the wheel and at the final cut all inequalities in the teeth at the time of the roughing cut are almost entirely removed. The finishing touches are given by examining the teeth under a microscope and scraping them to exact uniformity. In this way each dividing wheel is made ready to perform its important work.

The movement of the dividing wheel, which gives the necessary space to the teeth on a blank being cut, is brought about by a series of change gears whose general arrangement is shown in the elevation Fig. 2. A bracket (A) capable of vertical adjustment on the frame of the machine, holds the worm (C) in position with the dividing wheel. This vertical adjustment is designed to take up the very slight wear of the worm against the dividing wheel. Into this bracket is tapped a stud (B) which carries a loose pulley and a tight pulley keyed to gear (E). The position of the driving belt is fixed by guide fingers (adjustable if necessary), and is shown overlapping the tight pulley sufficiently to drive the train of gears during the interval of spacing the teeth, but not so far as to produce undue strain on the gears while locked for tooth cutting. Owing to this unique arrangement of the belt there is a constant pressure against the locking bolt, and when the tooth cutter has completed its cut across the gear blank, the forward feed of the dividing wheel is started on the instant of the release of the locking disc. It has been objected that this system of feed is not "positive," but the record of "not missed a tooth in fifteen years" is ample evidence that this arrangement is satisfactory and has the merit of extreme simplicity.

The locking disc, connected to the dividing pulley by gear E, consists of a graduated disc and the lock disc proper. On the circumference of the lock disc is a single notch, cut to receive the lock bolt, which is automatically withdrawn by the winding of a chain by one of the shafts of the cutter-driving mechanism. The bolt returns against the circumference of the lock disc, and prevents it from making more than one revolution, which corresponds to one tooth-space on the blank. Thus the number of teeth cut on a given blank is dependent upon the amount of feed given to the dividing wheel, and that is varied by inserting proper change gears between the locking disc and worm shafts. The graduated disc is clamped to the lock disc by means of bolts whose heads lie in a circular T-slot cut in the lock disc. This arrangement permits the gear blank to be turned to any position and the amount of change read in degrees on the graduated disc, without disturbing the locking mechanism or belting, by simply loosening the nuts on the outside.

* * *

## NEW GERMAN LINER.

On July 13 the "Deutschland," the new liner of the Hamburg-American line, arrived at her dockage, next to the desolate space where the North German Lloyd wharves were located in Hoboken, N. J. This vessel is shorter than the "Oceanic," the largest ship afloat, but has the greatest engine capacity of any vessel. A sea speed of 23 knots is guaranteed and an average of over 22 knots an hour was made during the maiden voyage, eclipsing any similar record. This vessel, and the "Kaiser Wilhelm der Grosse," of the North German Lloyd, impress one with the advanced position that is now taken by Germany in naval architecture and marine engineering.

The dimensions of the "Deutschland" are: Length over all, 686 ft. 6 in.; beam, 67 ft.; depth, 44 ft.; net tonnage, 16,000 tons; and displacement, 23,000 tons. The engines are twin screw of the quadruple expansion, six-cylinder type, of 33,000 collective horse power. Steam is furnished by boilers of the Scotch type, twelve double ended and four single ended, having altogether 112 furnaces. There are four groups of boilers, each in its own fire room, and each having uptakes connected with a separate funnel. The cylinders are of the following diameters: H. P. (2), 30.6 in.; first I. P., 73.6 in.; second I. P., 103.9 in.; L. P. (2), 106.3 in. dia and all of 72.8 in. stroke. The engines are designed with the two L. P. cylinders in the center, with the two H. P. over them tandem fashion, and the first intermediate at the forward end and the second intermediate at the after end. The new vessel is equipped in the most modern and luxurious manner, having comforts for passengers such as children's playroom, grill room, and gymnasium, in addition to those usually provided.

* * *

### LOCOMOTIVES WITH ARMOR STEEL FRAMES.

The Pittsburg Locomotive Works have built two enormous locomotives for the Pittsburg, Bessemer and Lake Erie Railway, the frames for which are constructed of armor plate steel furnished by the Carnegie Company, which owns the road in question. These locomotives are thought to be the largest that can be constructed for operation upon a standard gage line. The boilers are 86 in. in diameter at the smallest ring, are constructed of 1 in. steel, and carry a working pressure of 225 lbs. per square inch. One of these locomotives is to be sent to the Paris Exposition.

* * *

The proneness of the average passenger car window to stick and resist raising when some ubiquitous gentleman essays to be gallant to the fair lady passenger greatly in need of fresh air, has been an overworked joke with the comic papers for a number of decades. That universal lubricant graphite promises, however, to relieve the ancient chestnut of some of its forcefulness in the future, as the practice of using it on the car window slides has been adopted by at least one railroad (the Lackawanna) with very satisfactory results.

## LESSON FOR MACHINISTS

BY

THE UNITED CORRESPONDENCE SCHOOLS.

154, 156, 158 FIFTH AVENUE, NEW YORK.

These lessons are not intended to enter too deeply into the subjects treated, and mathematics will be simplified and omitted whenever possible. They will take up such points as machinists and others frequently meet in their work and with which many of them have found difficulty.

The readers of MACHINERY are invited to answer the questions and solve the examples in these examinations and to send their replies and solutions to The United Correspondence Schools, 156 Fifth Avenue, New York. Their work will be carefully examined, corrected, and returned, just as if the senders were regular students of the Schools. The Schools will also be pleased to answer any questions concerning the preceding lesson. Write your name and address on all matter sent to the Schools, in order to insure the prompt return of the work.

### THE WORM AND WORM WHEEL.

**The Pitch Lines—Pitch of Worm and Wheel—Properties of Teeth and Threads—Sizes of Blanks—The Helix—Proper Angle for Cutting the Teeth of Worm Wheels.**

In cutting the teeth of worm wheels, one of the first problems which arises is to find at what angle the teeth should be cut. In this lesson we shall consider the proper method of ascertaining the required angle and the size of the blank required, examining the conditions which must be considered, so that any machinist who will study this lesson can perfectly understand each step of the operation.

In Fig. 1 is shown a worm $a$, in mesh with a worm wheel $b$, of which only a part of the rim is shown. It will be observed that the worm is nothing more than a screw whose threads have a very large pitch, and that the worm wheel is only a spur gear wheel having its teeth cut at such an angle that they will bear along those portions of the threads of the worm which project into the teeth of the worm wheel.

The pitch circle of a worm wheel, as in other gear wheels, is the circle on which the teeth are laid off as $p\ l$, Fig. 1, and the pitch line of a worm is, as in a rack, the line on which widths of the threads are laid off $p'\ l'$, Fig. 1. In a worm and worm wheel, just as in a rack and pinion, the pitch lines should always be tangent. This is clearly shown in the figure, the pitch line $p'\ l'$ of the worm, being tangent with the pitch line $p\ l$ of the worm wheel.

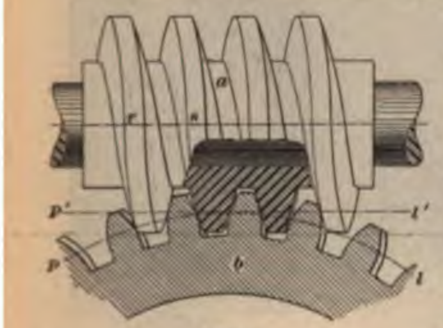


FIG. 1.

The pitch of the threads of a worm is equal to the sum of the widths of one thread and of a space measured on the pitch line, or, in other words, it is the distance between corresponding edges of two consecutive threads, measured on the pitch line. The pitch of the teeth of a worm wheel is also equal to the sum of the widths of a tooth and of a space measured on the pitch line. In the case of the worm, the pitch is measured on a straight line, while in the case of the worm wheel, it is measured on a curved line. The pitch of the teeth of a worm wheel must always be equal to the pitch of the threads of the worm with which it is to work. The pitch which has just been defined is called the "circular pitch" and this is the only pitch that will be considered in this lesson.

In calculations relating to worm wheels, when the "diameter of the wheel" is spoken of, it is always interpreted to mean the "diameter of the pitch circle," unless particularly designated as the "outside diameter" or "root diameter." In this lesson the "diameter" will always refer to that of the pitch circle, unless otherwise stated.

The circular pitch, the number of teeth and the diameter of the pitch circle of every worm wheel are so related that when any two of them are given, the third may be found. The following rules will show this relation.

**To find the diameter of the pitch circle of a worm wheel when the circular pitch and number of teeth are given.**

*Multiply the number of teeth in the wheel by the circular pitch in inches and divide the product by 3.1416.*

Example.—What is the diameter of the pitch circle of a worm wheel having 18 teeth and a circular pitch of 1"?

Solution.—According to the rule, the diameter of the pitch = $d = (1 \times 18) \div 3.1416 = 18 \div 3.1416 = 5.73"$. Ans.

**To find the number of teeth on a worm wheel.**

*Multiply the diameter of the pitch circle in inches by 3.1416 and divide the product by the circular pitch in inches.*

Example.—Find the number of teeth in a worm wheel whose circular pitch is 1.5708" and whose pitch diameter is 24".

Solution.—According to the rule the number of teeth in the wheel $= (24 \times 3.1416) \div 1.5708 = 48$ teeth. Ans.

**To find the circular pitch in inches.**

*Multiply the diameter of the pitch circle by 3.1416 and divide the product by the number of teeth in the wheel.*

Example.—Find the pitch of a worm wheel having 24 teeth and a pitch diameter of 12".

Solution.—According to the above rule, the circular pitch equals $(12 \times 3.1416) \div 24 = 1.5708"$. Ans.

The usual proportions for the teeth of worm wheels and for the threads of worms are as follows:

When the teeth and the threads are cut, the thickness of one thread or of one tooth, measured on the pitch line is equal to ½ the circular pitch. The length of that portion of the threads of the worm and of that portion of the teeth of the worm wheel which project outside of the pitch line is equal to .3 of the circular pitch, and the length of that portion of the threads of the worm and of that portion of the teeth of the worm wheel which lie inside of the pitch lines is equal to .35 of the circular pitch.

(*To be continued.*)

### EXAMINATION 1.

1. What is the principal difference between a worm wheel and a spur gear?
2. In Fig. 1 indicate the pitch circle of the worm wheel.
3. Indicate the pitch line of the worm.
4. What is meant by the pitch of a worm?
5. What is meant by the pitch of a worm wheel?
6. Will a worm wheel whose pitch is ¾ inches work properly with a worm whose pitch is ½ inch?
7. What must be the diameter of the pitch circle of a worm wheel having 36 teeth and a pitch of 1 inch? Ans. 11.46.
8. How many teeth must there be on a worm wheel whose diameter is 40 inches, and works with a worm whose pitch is 2.2562 inches? Ans. 30 teeth.
9. What is the diameter of a worm wheel having 20 teeth and a pitch diameter of 10 inches? *Ans.* 1.5708 inches.
10. What dimensions should be given to the teeth of a worm wheel and to the threads of a worm whose circular pitch is 1½ inches?

*Ans.* {
Thickness, ¾ inch.
Dist. outside pitch line, .45 inch.
Dist. inside pitch line, .525 inch.

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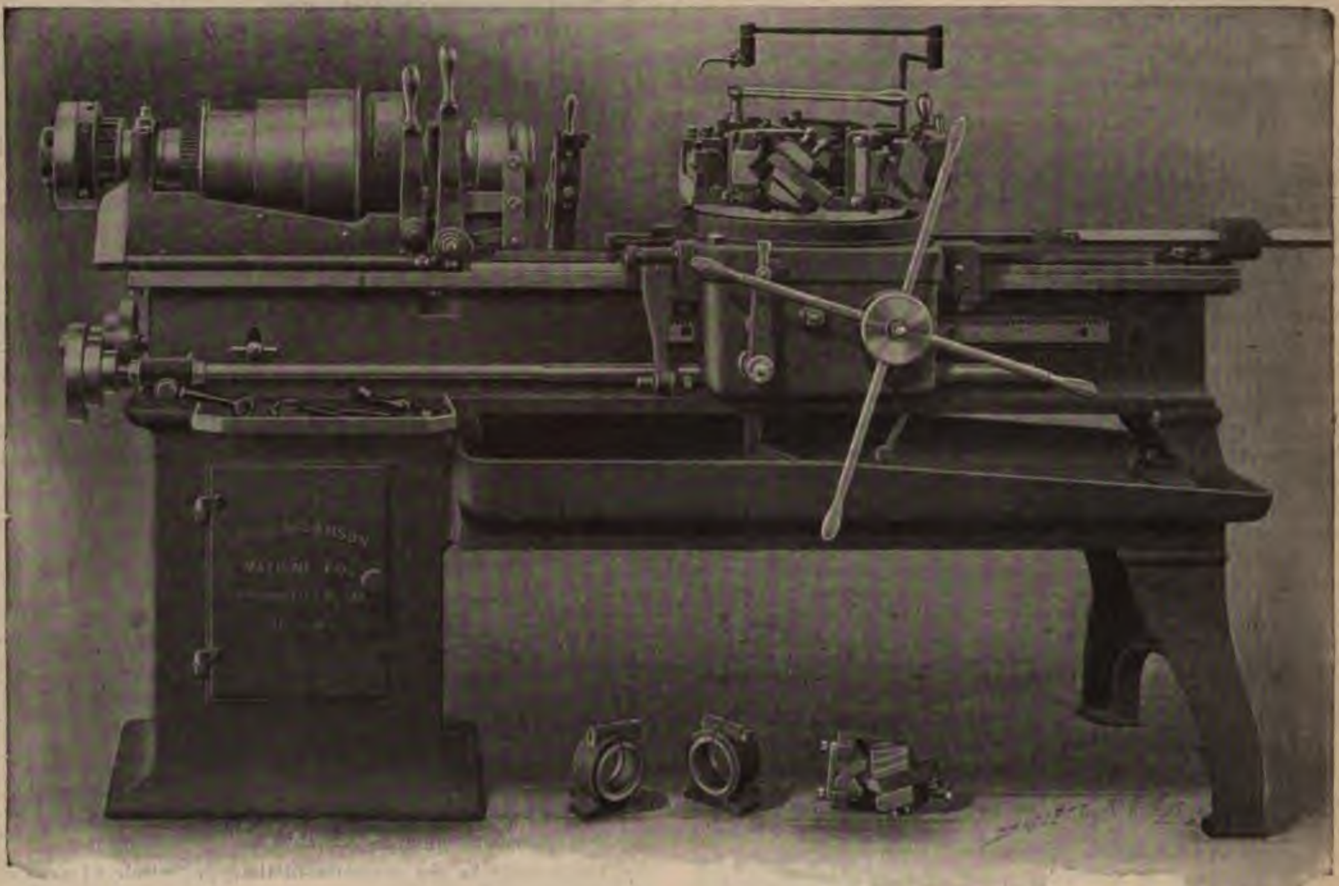
# *The Flat Turret Lathe.*

The Tools do not overhang.
The entire design is compact.
The locking pin is directly under the working tool.
The Turret is gibbed at its outer edge.
The Turret Slide does not overhang.
The chuck grips round, square and hexagon stock.
The tools do not mark the work in running back.
Tools are quickly set to any size.

Turret turns to the places desired only.
Each tool travels the length of its own cut only.
Each turning Tool and Back Rest readily adjusted to any size.
Only three levers to operate the cutting tools.
Only one shipper to operate the three-friction countershaft.
Oil follows the cut without attention.
Turning Tools are simplest form.



## *Other Points.*

The Bed rests on an improved tripod bearing.
New length of work obtained while running.
Back gears operated while running.

Four speeds for each position of the belt.
An automatic feed stop for each position of the turret.
Feed stops are independently adjustable.

Made in one size only. Capacity 2 in. in diameter when working from full length bars, and almost any diameter up to 16 in. when working from forgings. Any piece of work from a washer ⅛ in. thick to a shaft 24 in. or 36 in. long.

The outfit of tools furnished with the machine turns and threads all diameters from 2 in. down, and all lengths under 24 in.

## *Jones & Lamson Machine Company,*

*Springfield, Vermont, U. S. A.*

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HENRY KELLEY & Co., 26 Pall Mall, Manchester.
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FRANCE: Ph. Bonvillain, 6, Rue Blanche, 6, Paris.

# LESSON FOR MACHINISTS.

BY

## UNITED CORRESPONDENCE SCHOOLS.

154, 156, 158 FIFTH AVENUE, NEW YORK.

ons are not intended to enter too deeply into the subjects treated, atics will be simplified and omitted whenever possible. They will points as machinists and others frequently meet in their work and many of them have found difficulty

rs of MACHINERY are invited to answer the questions and solve es in these examinations and to send their replies and solutions d Correspondence Schools, 156 Fifth Avenue, New York. Their work fully examined, corrected, and returned, just as if the senders were ents of the Schools. The Schools will also be pleased to answer s concerning the following lesson. Write your name and address r sent to the Schools, in order to insure the prompt return of the

## GEAR WHEELS.

**tact - Relation between Diameter and Number of Revolutions - Pressure - Teeth Spaces Cast Gears - Cut Gears - Spur Gears - re must be used in Forming Gear Teeth.**

sson is the first of a series which we shall publish on eels. This lesson embraces some of the fundamental and the considerations here discussed form the foun- the subsequent lessons. After the fundamental prin- rious forms of Gear Teeth will be taken up. Methods ucting the involute, cycloid, epicycloid and hypocycloid ven Spur gearing, bevel gearing, and skew gearing will up and under each heading the proportions of the teeth elation existing between the number of teeth, diameter both on the diametral and circular pitch system will be

s of MACHINERY who are interested in gear wheels will o familiarize themselves with each article as it appears, e subsequent articles will be perfectly clear. While the ill not enter deeply into the theory of gearing, such tions as present themselves in designing gears and alculations relative to same will be taken up.

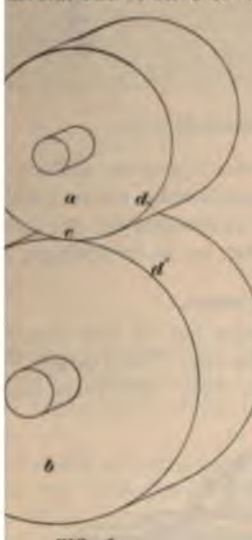

FIG. 1.

If two circular discs, as *a* and *b*, Fig. 1, be brought together with enough pressure and one of them turned, the motion will be transmitted to the second disc, which will also turn about its axis. If there be no slipping, the motion is said to be transmitted by **rolling contact.** In that case, points on the periphery or convex surfaces of one, will in the same time, move through equal distances. For instance, while the point *d*, Fig. 1, moved from *c*, a distance *cd* measured on the arc, the point *d'* would have moved a distance *cd'*, equal to *cd*.

readily be seen that if the two discs, or gears, as we call them, have the same diameter, they will make the ber of revolutions. If the diameter of one be doubled, t on it will get only half way around while a point on makes a complete revolution. Then, if we let $D =$ the of the larger wheel, $d =$ the diameter of the smaller wheel, number of revolutions made by the larger wheel and umber of revolutions made by the smaller, we have the proportion:

$$R : r = d : D$$

his we have the following two rules:

**—To find the number of revolutions made by one of gears.**

*ly together the diameter and the number of revolu- he other gear and divide the product by the diameter ar whose revolutions are to be found.*

**—To find the diameter of one of a pair of gears.**

*ly together the diameter and the number of revolutions of the other gear and divide the product by the number of revolutions of the gear whose diameter is to be found.*

*Example*—Three gears are to work together; the first, whose diameter is 8" and which makes 40 revolutions per minute, is to transmit its motion to the second, whose diameter is 32". This second gear transmits the motion to a third, which is to make 20 revolutions per minute. Find (*a*) the number of revolutions made by the second gear and (*b*) the diameter of the third.

*Solution*—Combine first, the first and second gears and apply **Rule. 1** By this, number of rev. $= (8 \times 40) \div 32 = 10$ rev. Ans (*a*).

Then, combining the second and third gears and applying **Rule 2,** we have, diameter $= (32 \times 10) \div 20 = 16$ rev. Ans. (*b*)

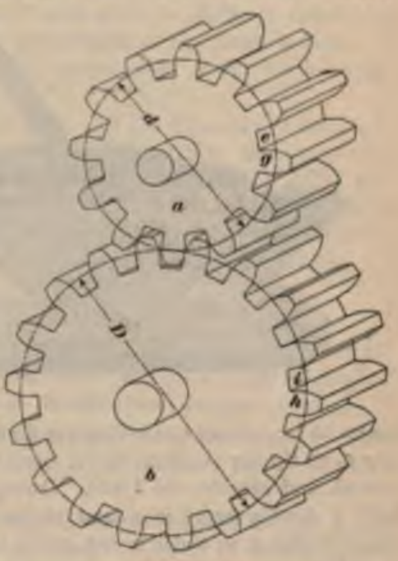

FIG. 2.

Now, in actual gears the motion is transmitted by **direct pressure.** This is obtained by providing the discs with grooves, as *e* and *i*, and projections *g* and *h*, as shown in Fig. 2. If these grooves and projections be so arranged that the projections of one disc enter the grooves in the other disc, it will prevent the slipping of one disc on the other and the projections of one will transmit the motion by pressing on those of the other.

If these projection be given a suitable form, an actual pair of **gear wheels,** or **gears,** as they are frequently called, will be formed, the projections forming the **teeth** of the gears and the grooves, the **spaces**

The various forms of gear teeth will be discussed in a subsequent lesson.

## EXAMINATION 2.

1. What is meant by "rolling contact?"
2. Two gear wheels whose diameters are 16 and 24 inches, respectively, work together. If the 16 inch wheel makes 80 revolutions per minute, how many will the other wheel make?
3. Two wheels working together, make 75 and 100 revolutions per minute, respectively. If the diameter of one of the wheels is 10 inches, what diameter must be given to the other wheel?
4. In actual gear wheels, how is it made possible to transmit the motion by direct pressure?
5. What is mean by "cast teeth?"
6. What is meant by "cut gears?"

When the teeth of gears are cast directly on the wheel, they are referred to as cast **teeth**, and the gears are said to be **cast gears. Cut gears** are those in which the grooves are *cut* in the peripheries of the disks, thus forming the **cut teeth**.

When the axes of the gears are parallel, as shown in Fig. 2, the gears are called **spur gears.**

The form of the teeth for spur gears is a matter involving careful study and the outlines and dimensions are matters for exact determination. The form must be such as to prevent the sliding of one tooth on another, for this would occasion too much loss of power through friction and cause too much wear on the teeth.

(To be continued.)

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### NEW WOOD TRIMMER.

The Oliver wood trimmer, made by the American Machinery Company, Grand Rapids, Mich., has recently been improved and the two accompanying views show clearly the new features. Instead of having a pair of knives bolted to a sliding knife head a solid knife is used which acts as a knife head also. The object of this is two-fold; as there is no joint made by bolting the knives to the knife head there is less liability of looseness there, and in sharpening the knives, which it is necessary to do frequently in order to obtain satisfactory service, there are no screws to be removed in taking the knife out. All that is necessary is to tip the machine up on edge to throw the handle clear around, and remove the blade. Owing to the thickness of the knife a double bevel is placed at the cutting edge, as plainly shown in Fig. 2, in order to reduce the labor of honing the edges. It will be noticed that the rack and gear are above instead of below the knife, in which latter position there is more or less trouble from clogging from chips.

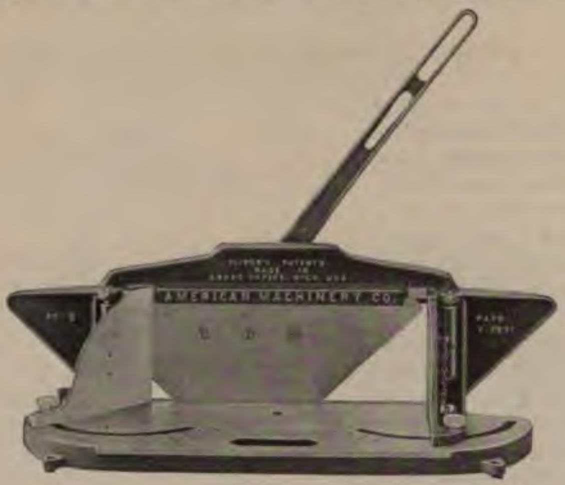


Fig. 1.

In order to overcome any tendency to tip and bind in cutting across a piece of wood, the short lower bearing of the knife is fitted to a steel shoe that exactly fits the groove in which it operates.

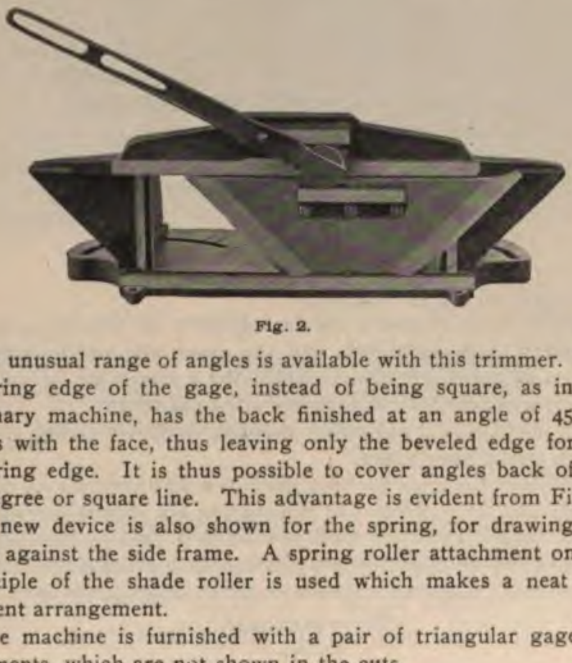


Fig. 2.

An unusual range of angles is available with this trimmer. The shearing edge of the gage, instead of being square, as in the ordinary machine, has the back finished at an angle of 45 degrees with the face, thus leaving only the beveled edge for the shearing edge. It is thus possible to cover angles back of the 90-degree or square line. This advantage is evident from Fig. 1.

A new device is also shown for the spring, for drawing the gage against the side frame. A spring roller attachment on the principle of the shade roller is used which makes a neat and efficient arrangement.

The machine is furnished with a pair of triangular gage attachments, which are not shown in the cuts.

### METAL TOOL TRAY.

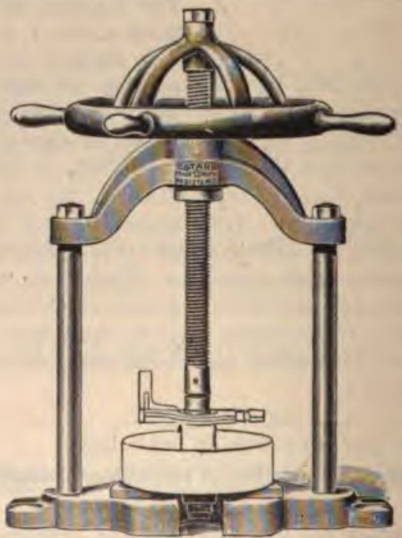
In the last number of the paper we called attention to the fact that the New Britain Machine Company, New Britain, Conn., had brought out a new portable tool tray or server which was intended to be a convenient receptacle for tools, finished work or castings. The half-tone here shown is from a photograph of one of these trays on which is a collection of tools which a workman gathers about him for use at a radial drill. The great convenience of having these tools at hand instead of scattered about is evident, and a metal rack is also better adapted to the purpose than a wooden one, which not only splinters, but becomes oil soaked. It is also equally convenient for screw-machine tools, lathe tools, or, in fact, for use at any machine, and is well adapted for assemblers' use because of its portable feature.

Tool Rack with Radial Drill Tools.

It is made, however, without castors if desired, and can be furnished of a height to pass underneath a lathe, where it will be out of the way and at the same time convenient for the lathesman. The dimensions are 20 by 26 inches by 32 inches high, and the weight 175 pounds.

### ARBOR PRESS.

An arbor press has been brought out by The Seneca Falls Mfg. Co., Seneca Falls, N. Y., called the "Star" Arbor Press, of which an illustration is shown herewith. The press consists of two uprights attached to a base, across the top of which is a cross rail in the center of which is the nut carrying the screw for forcing the arbor into or out of work. Underneath the pulley



Ball-bearing Arbor Press.

# LESSON FOR MACHINISTS.

BY

THE UNITED CORRESPONDENCE SCHOOLS.

154, 156, 158 FIFTH AVENUE, NEW YORK.

**These lessons are not intended to enter too deeply into the subjects treated, and mathematics will be simplified and omitted whenever possible. They will take up such points as machinists and others frequently meet in their work and with which many of them have found difficulty.**

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## GEAR WHEELS.

**The Rack—Pitch Circle—Pitch Line—Root Diameter—Outside Diameter—Root Circle—Root Line—Circular Pitch—Face—Flank—Addendum—Dedendum—Addendum Circle—Addendum Line—Back Lash—Bottom Clearance—Working Depth—To Find the Diameter of the Pitch Circle—To Find the Number of Teeth—To Find the Circular Pitch.**

There are two forms of gear teeth in common use, and they are named after the curves which form the outlines of the teeth. Before going into the method of constructing these curves it is necessary to thoroughly understand the various terms used to designate the parts of the teeth.

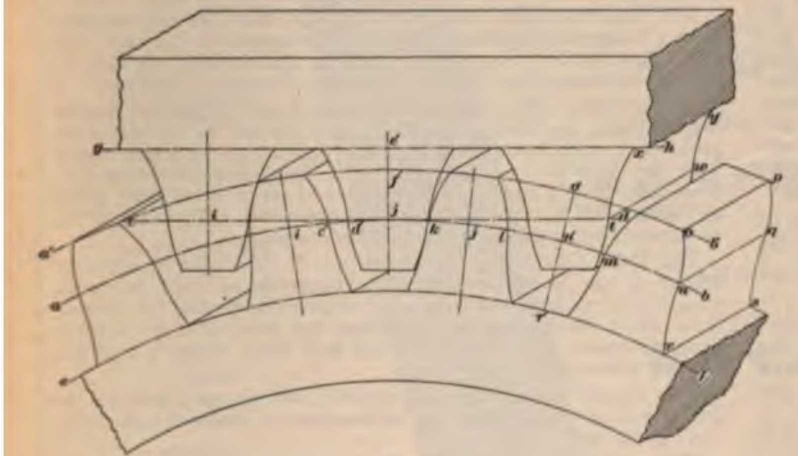

FIG. 3.

Fig. 3 shows a portion of the rim of a spur gear and a portion of a rack with which it works. A **rack** may be considered as a gear wheel whose rim is straight instead of being curved around in a circle.

The **pitch circle** of a gear wheel represents the periphery of the disc which has been provided with grooves and teeth as shown in the preceding lesson, and on which the projections forming that part of its teeth which lies beyond the periphery have been placed. In order, therefore, that the proper action take place between two gears which work together, their pitch circles should always be tangent just like the peripheries of the two discs shown in Fig. 1 of the preceding lesson.

In Fig. 3, the line $ab$ is a portion of the pitch circle of the gear. In a rack, the pitch circle is replaced by a straight line called the **pitch line,** as $cd$. The diameter of the wheel to the bottom of the teeth, as for instance, to the line $ef$, is called the **root diameter** of the gear; and the diameter to the outside of the teeth $a'\ b'$ is called the **outside diameter** of the gear wheel, $ef$ being called the **root circle** of the gear, and $gh$ the root line of the rack.

The distance between the center lines of two consecutive teeth measured along the pitch line is called the **circular pitch,** or, simply, the **pitch**  This circular pitch is divided into two parts—$kl$ the thickness of a tooth and $lm$ the width of a space.

That portion of the acting surface of a tooth which lies *outside* of the pitch line, as $n\ o\ p\ q$, is called the **face** of the tooth of the wheel whose pitch circle is $ab$. That part of the same surface which lies *inside* of the pitch circle, as $n\ r\ s\ q$, is called the **flank** of the tooth. The same designations are given to corresponding portions of the rack teeth according as they lie inside or outside of the pitch lines. The distance $n'\ o'$ between the end of the tooth and the pitch line is called the **addendum;** and in the case of a gear wheel, the circle $a'\ b'$ passing around the outside of the tooth is called the **addendum circle.** The line passing through the ends of the rack teeth is called the **addendum line.** The distance between the pitch circle and the root circle, as $n\ r'$ is called the **dedendum.** The difference between the width of a space $lm$ and the thickness of a tooth $kl$ measured on the pitch line as $c'\ d'$ is called the **back lash,** and the distance $e'\ f$ measured from the addendum circle of one gear to the root line of the gear or rack with which it works is called the **bottom clearance.** The **working depth** of the tooth is equal to twice the addendum, or to the entire depth of the tooth minus the bottom clearance.

The pitch, the number of teeth, and the diameter of the pitch circle of every gear are so closely related that when any two are given, the third may easily be found. Thus, if D = the diameter of the pitch circle in inches, P = the circular pitch in inches and N = the number of teeth in the wheel, then the relation between the three quantities is expressed by the formula

$$3.1416\ D = P.\ N.$$

from which we have the following rules:

**To find the diameter of the pitch circle in inches** *multiply the circular pitch of the pitch circle in inches by the number of teeth on the wheel and divide the resultant product by 3.1416.*

**To find the number of teeth on a wheel** *divide 3.1416 times the diameter of the pitch circle in inches by the circular pitch in inches.*

**To find the circular pitch in inches** *divide 3.1416 times the diameter of the pitch circle in inches by the number of teeth on the wheel.*

### EXAMINATION 3.

1. What is a rack ?
2. What is meant by the pitch circle of a gear wheel.
3. What takes the place of the pitch circle in a rack ?
4. (a) What is meant by the root diameter ?
   (b) By the root circle or root line ?
5. What is the circular pitch and into what two parts may it be divided ?
6. (a) What is the face of a tooth ?
   (b) What is the flank of a tooth ?
7. What is the line passing through the ends of rack teeth called?
8. How is the back lash measured?
9. Define bottom clearance and working depth.
10. What will be the diameter of the pitch circle of a spur gear whose pitch is 1 inch, and which has 18 teeth? Ans. 5.73 inches.
11. Find the number of teeth in a gear whose circular pitch is 1.5708 inches, and whose pitch diameter is 24 inches. Ans. 48 teeth.
12. Find the pitch of a wheel having 24 teeth and a pitch diameter of 12 inches. Ans. 1.5708 inches.

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Two chapters are devoted to pumps and three to hydraulic presses. The subject of hydraulic motors is treated as its importance deserves, there being seventy-five pages given it. One chapter is given to the design of turbines and the mathematical treatment of the reaction wheel is well worked out.

We believe that the student will make no mistake in obtaining this work, as it will repay much study. To the designer it cannot fail to be of value, as the suggestions and points demonstrated show that the writer is well informed on the subject of hydraulic engineering.

Electric Wiring, by Cecil C. Poole. Published by the Power Publishing Co., New York. 101 pages, 12 mo. Price $1.00.

The author states that this book is designed to serve both as an instructor for practical wiremen who have occasion to lay out their own work, and as a convenience and general reference work for electrical engineers whose work includes the calculation of transmission circuits, etc. From a brief examination of it we believe that his intention has been well carried out, as the work appears to be quite comprehensive with the general absence of unnecessary matter. An important feature of the book is the matter relating to alternating current wiring. This rather abstruse subject has been reduced to simple working conditions which will make it very acceptable to the average wireman and none the less so to the electrician. The text is accompanied by forty-six diagrams which materially assist in understanding the subject.

Compound Engines, by F. R. Low. A series of articles reprinted for the columns of Power. Published by the Power Publishing Co., New York. 50 8vo pages and 37 cuts. Price 50 cents.

This work is issued in the same form as "Condensers," by the same author, and both are reprints of articles that have appeared in past issues of "Power." Those already familiar with the articles will need no further commendation and will undoubtedly appreciate the opportunity to secure them in the convenient bound form. To those that have not read them we can say that they will secure a valuable addition to their technical library by obtaining this little pamphlet. In indicating the compound engine, the relation and analysis of the composite diagrams and their combination into one to show the total work, is important. The action that takes place in the receiver, whether tandem compound or cross-compound, is naturally quite confusing, especially to the beginner in steam engineering. The diagrams and explanations given will be found to be of much help as they are presented in the clear manner which always characterizes the work of this writer.

The Gas Engine Hand-book, by E. W. Roberts. A manual of information for the designer and engineer. Published by the Gas Engine Publishing Co., Cincinnati, O. 220 16mo pages and 39 original engravings.

The author of this work is an expert on the design, construction and operation of the gas engine, and is the writer of the valuable articles now appearing in the columns of MACHINERY on "Gas Engine Design." The three cycles used in various gas engines are described with the advantage and disadvantages of each. The important subject of gas engine fuels is taken up and a table given giving the comparative relative values in thermal units for the various fuels. Not the least valuable portion of the work is that devoted to the instruction of the engineer, many of the hints and instructions being sufficient, if heeded, to correct the abuses which are responsible for the ill-repute of what is, undoubtedly, the coming motor. A brief summary of the subjects treated will give the reader an idea of the scope of the book. Handling a Gasoline Engine, Igniters, Valve Mechanisms, Governors, Starters, Engines for Automobiles, Gas Engine Diagrams, Gas Engine Dimensions, The Cylinder, Valves and Valve Boxes, The Piston, Connecting-rod and Crank-shaft, etc. The formulas given are in many cases the result of personal deduction from the author's own experience.

## ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9 x 12, 6 x 9 AND 3½ x 6 INCHES. THE 6 x 9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

The Fellows Gear Shaper Co., Springfield, Vt. Catalogue of the Fellows Gear Shaper, illustrated.

This is one of the catalogues that appeals to the superintendent who desires to look into the merits of a machine and become conversant with its work before purchasing. The catalogue is filled with handsome engravings, the typography and press work are of the highest class, the cover is handsomely embossed, and altogether it is a very attractive production. The valuable point about it, however, is that all the features of this gear shaper, its operation and its theory, about which a person would naturally wish to know, are clearly and fully explained both by text and illustration. It is a model catalogue in all respects.

The Ball Bearing Co., Watson St., Boston, Mass. Catalogue of ball bearings and roller bearings.

The business of this company, like Baby Ruth whose portrait adorns the cover of their catalogue, appears to be growing. On the rear cover is an illustration of an automobile indicative of the new industry that is calling for large quantities of ball and roller bearings. Special designs for automobile bearings are shown and some other new forms of bearings. The catalogue has flexible covers and is in the same attractive style as previous ones.

Two catalogues of colleges giving instruction in mechanical engineering have been received. One of these is from the State Agricultural College, Burlington, Vt., which is fully illustrated. The other is from the Rose Polytechnic Institute, Terre Haute, Ind.

The Chisholm & Moore Mfg. Co., Cleveland, O., have sent us a catalogue of hoists, cranes, pneumatic tools and a variety of other products that cannot well be classified. The catalogue contains 135 pages and is illustrated.

Edgar T. Ward & Son, 25 Purchase Street, Boston, Mass., have sent us a catalogue and a list of steel and steel wire. A great variety of both tool and machine steel, wire, sheet steel, etc., is listed and the pamphlet also contains a steel-tempering diagram printed in colors.

Perry Ransom, Oshkosh, Wis., has issued a new catalogue of grinding and polishing machinery which contains, besides the usual line of such machinery, a description of the Vulcan disc grinder.

The General Supply Co., 40 John street, New York City, are headquarters for all kinds of machinery and supplies for factories, mills, railroads, steamships and mines. They have issued a most attractive catalogue which is generously illustrated throughout and contains a fund of valuable information for ready reference. Copies, we are informed, may be obtained free of any expense by those interested upon application.

## MANUFACTURERS' NOTES.

The firm of Hurd & Co., engineers and machinists, 570-576 West Broadway, New York, has recently been organized. They have a plant suited to model work and light machine building and are prepared to take hold of specialties that promise well.

The American Machine & Foundry Co. have leased the plant of the Hanover Foundry & Machine Company, of this city, and, after thoroughly re-equipping it, will manufacture all the tobacco machinery used by the American Tobacco Company.

A consulting office has been opened at the Marquette Building, Chicago, by George M. Brill, who has had an extended experience in mechanical engineering and in constructive work. He was formerly an engineer with the Solvay Process Co., Syracuse, N. Y., and later designed and constructed their plant at Detroit, Mich. He has also been connected with Swift & Co. as supervising engineer of their different plants.

The Pratt Chuck Co., of Frankfort, N. Y., have recently installed a 150 H. P. engine. The demands of their business, which have made it necessary to increase the power for driving their plant, have come largely from the sales of their positive driving chuck, which prevents the drill from slipping and becoming defaced.

The Goodell-Pratt Co., Greenfield, Mass., are building an addition of 40 x 60 feet, giving an increase of space of something over 3,000 feet.

The students at Springfield, Mass., who are studying with the International Correspondence Schools, and of whom there are over 600 in that city, have recently given an exhibition of their work. The exhibition was held at the Art Museum and consisted largely of drawings.

No belt user can afford to stop the slipping of his belts with any material which will injure them. This claim of stoppage of all slipping, combined with the perfect preservation of leather, cotton, rubber or rope, is what the Cling-Surface Mfg. Co., of Buffalo, N. Y., desire to emphasize for cling-surface.

The Hamilton Carhartt Co., manufacturers of workingmen's clothing, Detroit, Mich., have built up an excellent trade in every state in the country and do business in a model establishment, under rules which illustrate what may be accomplished by maintaining harmonious relations between capital and labor. The Hamilton Carhartt Co. offer to send a self-measuring tape and an illustrated book free to readers of MACHINERY, and also to send their goods by express where they cannot be obtained from a local dealer.

The Burt Mfg. Co., of Akron, O., manufacturers of the Cross Oil Filters, recently entered their 12th order from the National Steel Co., 12th from the American Tin Plate Co., 9th from the American Steel & Wire Co., 7th from the Federal Steel Co., 4th from the Pittsburg Plate Glass Co., 4th from the Calumet & Hecla Mining Co., and duplicate orders from the Cambria Steel Co., Diamond Match Co. and National Cash Register Co.

America has become the workshop of the world. Immense resources and economic methods of manufacture enable her to compete successfully with all other manufacturing countries in their own markets, and during the next few years the expansion of her trade will become the talk of the world. The great impetus recently given to all technical trades and professions, by the commencement of a new era of commercial prosperity, has forcibly brought to the attention of the public the great value of technical education, acquired simultaneously with practical ex-

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Largest Dealers in each City.

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**We pay**

especial attention to:
1. Steel: Best Crucible Cast and High Carbon.
2. Temper: Hardened Through and Through.

**Have you**

received a copy of our "FILE FILOSOPHY"?
Tells all about files and their uses. Now in its third edition. Send for one free.

**NICHOLSON FILE CO., Providence, R. I., U. S. A.**

Sam'l M. Nicholson, Pres't and Gen. Mgr.

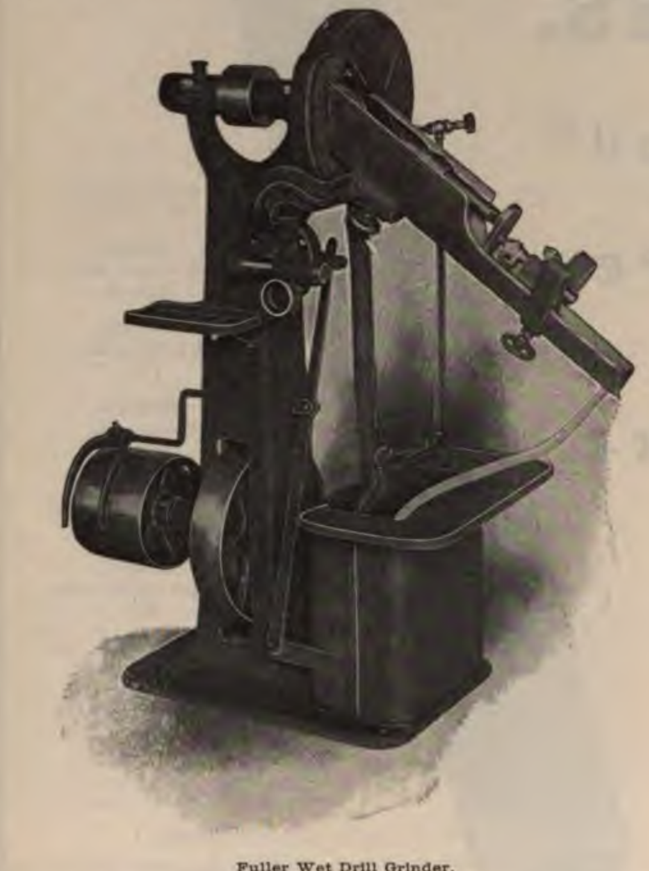
Largest Makers of Files in the World.

This tool is at present made only in one size, under the supervision of Mr. Edward Rivett (the maker of the Rivett precision lathe), by the Rivett-Dock Company, Brighton, Mass., but they intend also to put it on the market in a larger and smaller size, the three sizes covering any ordinary range of work. Cutters are furnished for U. S., V and Acme threads, and will be made to order for any angle desired.

### A NEW WET DRILL GRINDER.

The machine illustrated herewith is one that will be of interest to users of large drills. Heretofore a large proportion of the drill grinders made have been the common dry wheel grinder, which is all right for small drills or those of medium size. It is a fact, however, that where drills run from medium to large in size there is so much steel to be removed in the grinding that the temper is very liable to become impaired and the drill softened if ground on a dry wheel. As is well known, when the drill steel becomes impaired or softened by dry grinding it does not cut with maximum efficiency, and the drill also needs regrinding considerably oftener.

The machine shown herewith has a large range, viz., from about ⅝" to 3½" drills. It has all of the advantages of the new "Yankee" self-adjusted method of drill grinding. It is only necessary to drop the drill into the "V"-grooved holder, and bring up the tailstock to suit the length of the drill, taking perhaps one or two seconds of time. This arrangement saves money every time a drill is ground, and also enables cheaper help to use the machine than if it were more complicated.



Fuller Wet Drill Grinder.

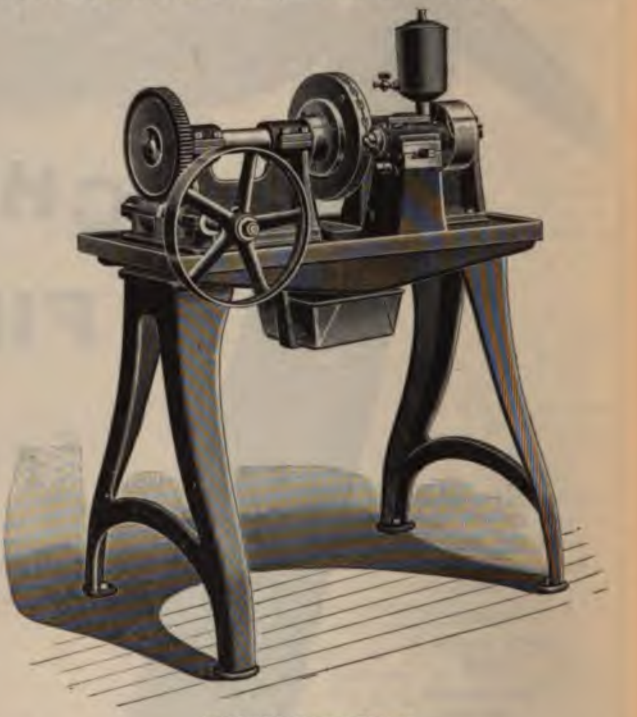
The shape given to the point of the drill is theoretically correct, and the machine can be adjusted instantly to give any angle of clearance desired for working either soft or hard metals. It also grinds flat drills, three or four lipped drills and chucking reamers.

There are a number of special points of advantage worthy of note in the construction of this machine. The pump is one that will also give little trouble, as its construction is such that there are no joints or packings that can be affected by particles of emery or steel in the water. The water is delivered on the wheel in such a manner that there is no splash or gush, and is perfectly returned to the tank. The construction of the "Yankee" holder is especially adapted to retain any overflow caught by the drill, and to return the same to the tank by means of a flexible hose attached to the lower end of the holder.

This machine is furnished electrically driven, if desired. It is made by The Fuller Mfg. Co., Kalamazoo, Mich., who make a special line of drill grinders adapted to grind every size of drill from No. 60 up to 5" in diameter.

### SCREW SLOTTING MACHINE.

This machine is designed especially to facilitate the slotting of screws where the quantity does not warrant the use of a high price automatic machine and supersedes the old style of hand slotting device. It is driven by a worm wheel that carries two discs in front of the slotting saw. These discs are set at an angle to each other and are fitted with depressions, or jaws, into which the screws are fed by hand. They open in front, where the operator inserts the screw, closing in back when they reach the saw, thereby holding the screw firmly during the process of slotting, after which they drop by gravity from the discs. Each machine is fitted with one set of discs made to carry the class of screw for which the machine is to be used.



Hubbell's Screw Slotter.

The discs used for slotting regular screws have a range of six sizes; that is, they are made to carry screws from No. 2 to No. 7, inclusive, or No. 3 to No. 8, inclusive, etc., up to No. 8 to No. 14, according to requirements. For fillister head screws a different style of disc is necessary. Extra discs can be furnished for any special screws. By continuous feeding this machine will slot 30,000 brass and 15,000 iron screws per day.

This machine is made to order only by Harvey Hubbell, Bridgeport, Conn.

### NEW UNIVERSAL DRILL GRINDER.

One of the pioneer drill grinders is that which has been made for many years by the Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass., and our readers will be interested to know that these shops have now brought out a new universal grinder capable of grinding a great variety of drills. Particular care has been taken to so support the drill that it will have the most clearance near its point, where its velocity is the least and the increased clearance is needed. The reason for this will be evident if it be considered that should the outer corner of the drill be ground with the greater clearance, the drill would be weakened where the strength is most needed. As the drill holder is oscillated, it receives automatically a slight vertical motion, which gives the drill theoretically the best clearance that it is possible to obtain.

The drill is held in a V-shaped holder which properly centers and locates each size. A hardened steel rest at the grinding end of the holder determines the position of the drill lip. The holder is adapted to drills having a large shank as well as to those with a small shank, and to flat and chucking drills, etc. Any desired clearance can be obtained by turning a knurled index at the base of the holder. The steel rest for the drill lip can be adjusted, and any angle can be given to the point of the drill by changing the inclination of the drill holder, which adjustment does not

# NEW TOOLS OF THE MONTH.

**Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.**

## A NEW THREAD-CUTTING TOOL.

The accompanying cuts show a thread tool that marks a radical departure in the art of cutting threads in the engine lathe. The essential feature of this tool is that instead of depending on one tool point for roughing and finishing a thread, a number are provided, each of which performs a specific operation, and when the cycle is completed, the thread is finished. The first tool has a broad point, and those that follow narrow down in proportion to the depth of thread cut, the V-point being reserved for the last operation. That this has an important advantage is self-evident when it is considered that with the ordinary threading tool the point is exposed to the severest part of the work, and its preservation demands a lathe speed considerably below what is good practice with a broad point tool, on the same material.

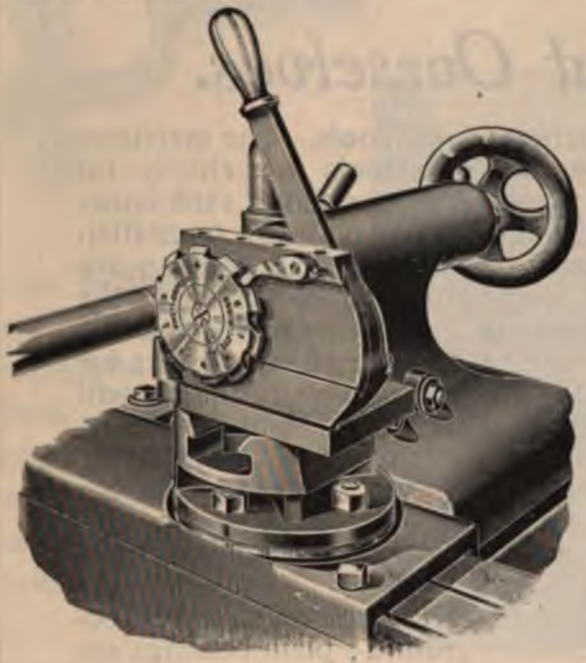


Fig. 1. Rivett-Dock Thread Tool in Position for Cutting a Thread.

Fig. 1 shows the tool mounted for thread cutting in an ordinary engine lathe. Beyond the fact that it is necessary to have a space block of the proper thickness to get the right height, the tool is adapted for use on any standard lathe, and is fastened with a T-head bolt engaged in the slot for the tool-post. To cut a thread the tool is run into the work until the cutter marked No. 1 takes a light cut. The lead screw is engaged and a cut taken in the ordinary manner. At the end of the travel the lathe is reversed and the hand lever thrown back from the position shown until it strikes a stop screw at the back. When the carriage has returned the tool to the beginning of the thread, the hand lever is thrown towards the work and a second tool point of the disc is engaged in the cut, since, in the backward motion, the pawl shown has turned the cutter disc through one space. No adjustment of the cross-feed screw is required, as the radial length of the cutters increases proportionately for each until the finishing tooth or No. 0 is reached. Since the number of cutters in the disc is ten, ten passes of the tool over the work are sufficient to form a perfect thread, and the operation is carried on with a peripheral speed of the work of about double that which is possible with the ordinary thread tool.

The tool is set to the work by an ordinary square held against the face of the cutter disc and the work. As the disc has a diameter of about three inches, the setting can be more accurately effected than by the thread gage on the ordinary single point tool. The cutter disc is adjusted for the proper side clearance, for either right or left hand threads, by tipping it on the space block S shown in Fig. 2. This is done by adjusting the screw P in the proper direction and then locking the binding nut R which rests on a washer having its under surface spherical shaped and fitted in a cavity of the same shape.

When cutting threads on taps or for similar work that requires great exactness, the operation is identical with that already described until the finishing cuts are taken. These are effected by repeated passes with tool No. 0, until the required smoothness and accuracy of size are reached, and this is done by throwing the pawl out of action when cutter No. 0 is reached. Then for each pass over the thread the cutter is advanced by a fraction of one one-thousandth of an inch by shifting the micrometer lever L, shown in Fig. 2, upward one hole for each pass over the work. The action of the micrometer device can be understood by reference to Fig. 3. The end M of the shaft on which the lever L is mounted is slightly eccentric, and as it forms the crank pin by which the slide A carrying the cutter disc is operated, the effect of turning the lever L through one space is to advance the cutter into the work a very short distance.

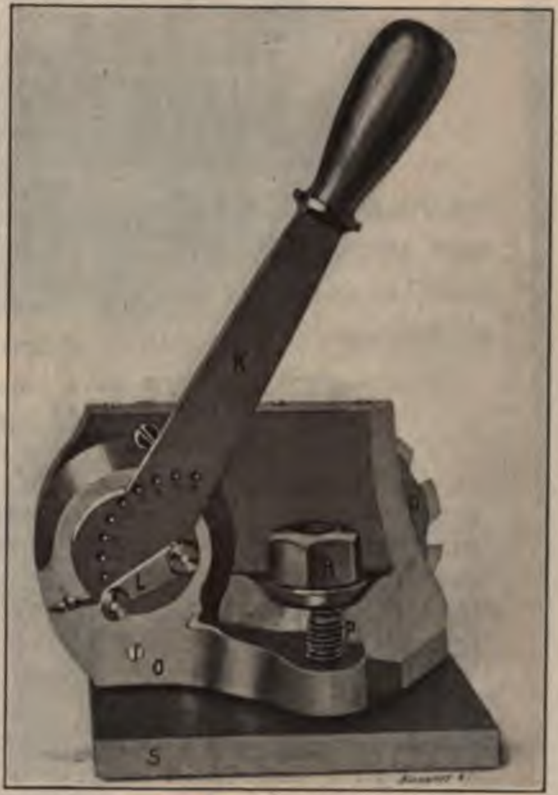


Fig. 2. Showing Micrometric Device.

Fig. 3 shows the back of the slide and also a section through the frame at right angles to it, showing the construction of the hand lever K. The crank-pin M engages in a hole in the sliding piece B, which works in the vertical slot H. The cutter disc is held to the slide by a screw E passing through an annular shouldered disc G, on which are mounted three pins F F F that engage in corresponding holes in the slide. The disc G can be adjusted by the screw E so that the cutter disc will be held with sufficient friction against the slide to hold it in any desired position, but still allow it to rotate when brought against the pawl. While taking the cut the tooth engaged is supported by an abutment directly beneath it so that there is no strain on the working parts incident to the pressure of the cut.

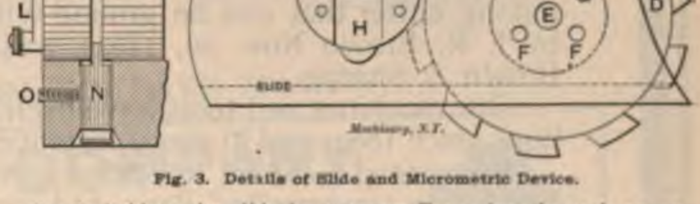


Fig. 3. Details of Slide and Micrometric Device.

# *Something About Ourselves.*

Our business is the manufacture of Machinery and Tools. The machines are principally used for working metals, and the tools are chiefly for machinists' use. It was established in 1833, and incorporated in 1868 under the present name. After twenty years, though we had earned a reputation for producing the best and most accurate work, we only had 1800 square feet of floor space. But from 1859, when we began the manufacture of the Willcox & Gibbs Sewing Machine, the business increased rapidly and the buildings, never well suited to manufacturing, became crowded. In 1872 we had more than three hundred workmen, and decided to move to the present location. The plant has continued to grow until the present buildings, which are said to be among the best in America for our line of work, have a floor space of about seven acres, and more than two thousand men are employed.

Throughout the works the tools and appliances are such as to meet the requirements of the latest machine-shop practice.

We intend that the machines and tools shall be the best of their respective classes. Cylindrical bearings are accurately ground; plain bearings are scraped to surface plates; alignments are correct.

All machinery and tools are subject to rigid inspection; and, when deemed necessary, to actual operation before being packed.

Many of the machines and tools that we now manufacture and carry in stock are the outgrowth of our own needs in manufacturing.

The Original Universal Milling Machine was designed by J. R. Brown in 1862, and patented Feb. 21, 1865. This machine is shown at our exhibit in the U. S. Machinery Building, Vincennes. It is still capable of doing good work, and serves as an excellent example of the high grade of our workmanship.

The first successful Universal Grinding Machine, patented by J. R. Brown in 1877, was also originated at our works, and the well-known form of milling cutter that can be ground without changing the outline (patented by J. R. Brown Nov. 29, 1864), was first made and introduced by J. R. Brown & Sharpe.

Our machines and tools have been shown at all the International Exhibitions since 1862, and in every instance have received highest awards.

We extend a cordial invitation to visit our exhibits at the "International Exposition Universelle," Paris, and we are always pleased to receive visitors at our works in Providence, R. I.

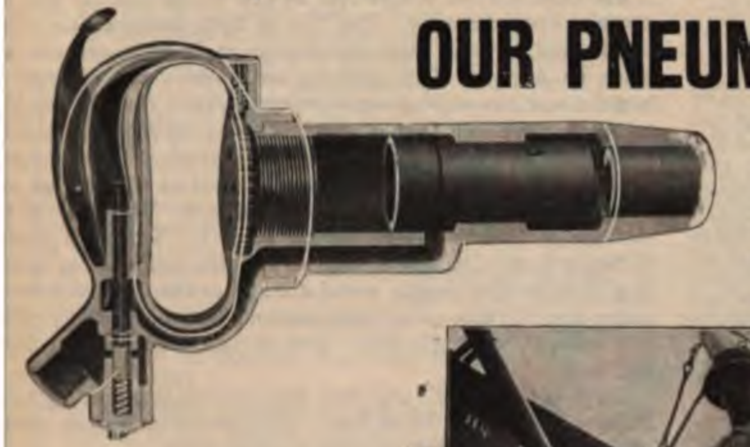
**"International Exposition Universelle," Paris.**
U. S. Machinery Building, Vincennes.
Palace of Machinery and Electricity, and
Palace of Liberal Arts, Champ de Mars.

*Brown & Sharpe Mfg. Co.*

# THERE ARE TOOLS AND TOOLS

## The Question is, which will do your particular work, and do it the best.

## OUR PNEUMATIC TOOLS

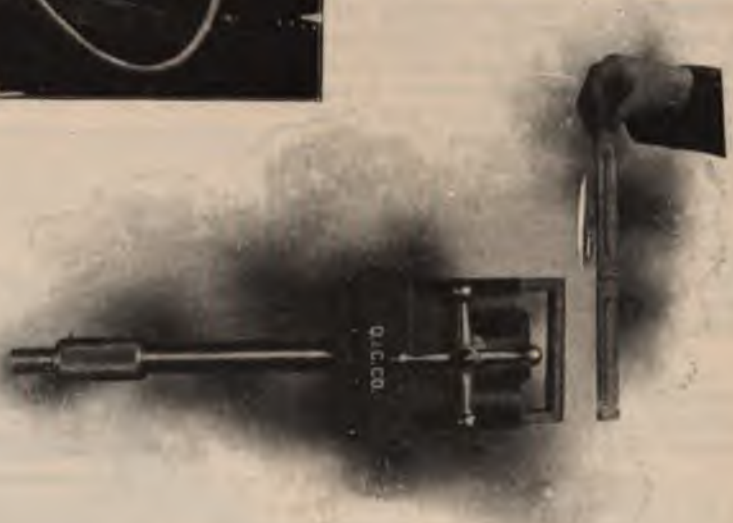


Being so simply and lightly constructed and free from vibration, are the most desirable tools for all kinds of work where a pneumatic appliance can be used.

Our hammers for chipping, calking, beading and riveting, give excellent satisfaction. They can always be depended upon to be in good condition and to discharge their duties in a most workmanlike manner.

We guarantee our riveters to do perfectly tight work, upsetting the rivet throughout its entire length, not simply making a nice looking head; and this with a minimum of air.

This drill for reaming and heavy drilling is of the piston type with cut off at three quarters stroke. It will drive a 3 inch drill up to its capacity. Small air consumption. Great power.

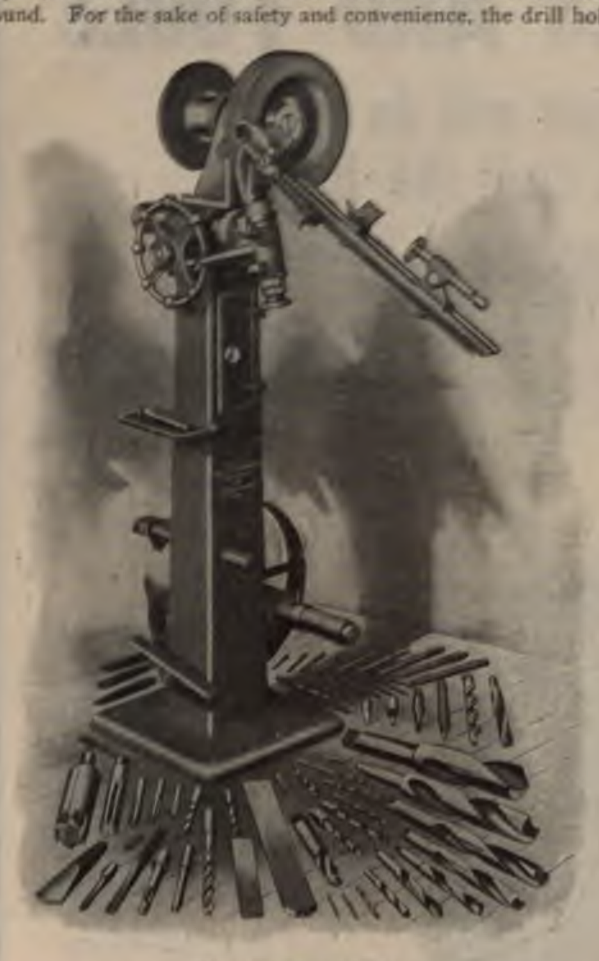


WE SEND OUR TOOLS ON TEN DAYS' TRIAL.

**THE Q. & C. COMPANY,**
**700-712 Western Union Building, Chicago.**
**106 Liberty Street, New York.**
ST. LOUIS, 403 Security Building.
ST. PAUL, 109 Endicott Arcade.
MONTREAL, 17 Place d' Armes Hill.
OMAHA, 1212 Farnam Street.
SAN FRANCISCO, 49 Wells Fargo & Co's. Bldg.
SEATTLE, WASH., Reimer Hotel.
DENVER, COL., 317 Cooper Building.
ATLANTA, GA., 607 English-American Bldg.
CINCINNATI, 615 Johnston Building.
BOSTON, 78 Mason Building.
LONDON, Chas. Churchill & Co., No. 9 Leonard St.

interfere with the setting of the rest. When these adjustments are once effected they are correct for all diameters of drills.

The adjustment for drills of various sizes is made by setting the caliper jaws at the left of the holder to the diameter of drill to be ground. For the sake of safety and convenience, the drill holder can be drawn away from the grinding wheel while the drill is being placed and then quickly returned. At the end of the arm which supports the drill holder is a joint operated by a horizontal handle. This serves to bring the drill into contact with any part of the grinding surface of the wheel. It also serves as a means of truing the face of the wheel with a diamond which can be placed in the holder.



Worcester Drill Grinder.

These grinders are the result of much study and many years of experience and they are well made. There are positive adjustments for wear, forged steel spindles and long, well protected bearings extending well into the pulleys. The novel features are covered by the Walker & Chandler patents.

### NEW 24-INCH LATHE.

The accompanying illustration shows a new 24-inch lathe that has recently been placed on the market by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, which embodies some novel features that their experience indicates are to be desired in a heavy lathe for modern requirements.

The headstock casting is cored out for the spindle bearings and lined with babbitt metal without the use of a bushing or shell. The babbitt is first poured in, is then pressed in place by hydraulic pressure, and is finally bored and scraped to a bearing upon the spindle. The bearings are in two parts, the lower half being solid with the headstock and the cap is tongued and bolted to the lower part. The general proportions may be judged by the front bearing, which is 4¾ by 8 inches.

There is an oil cup cast in the cap of each spindle bearing and fitted with a cover. The cup is dust proof and is divided into vertical sections, into one of which the oil is poured. The other section is closed and oil can enter it only through wicking between the two chambers. From the second chamber the oil runs to the bearing through an oil hole. The builders have adopted the Babbitt bearings in preference to bronze because they believe they are less likely to tear or scratch the spindle and that they will last indefinitely.

It will be noticed that the tail stock barrel overhangs the body of the tail stock about four inches, which enables the operator to use the lathe with the tail stock spindle protruding but very little from the body of the casting. The tail center will reach practically three-fourths across the throat of the carriage, without running out the tail spindle.

The head and tail stocks rest on one V and one flat and the carriage does the same. The V's in both instances are large and instead of being made the regular angle of 45 degrees, are made 60 degrees. This construction enables the carriage to keep its bearings without regard to temperature changes, the idea being the same that is carried out in many machines of late design, such as grinding machines, for example. With the two Vs, if the cuttings fall down upon the throat of the carriage and heat it, the back bearing is immediately lost. The drive of the carriage is directly underneath the large V. The sides of this V, being at an acute angle, take up the side strains more nearly as a slide at right angles would do, and as the drive is directly under this V, there is but little tendency for the carriage to lift as a result of twisting strains. The carriage is gibbed both front and back.

There is both a belt and gear feed and the latter will give 26 changes independent of the belt. The apron arrangement is substantially like that used on most modern tools.

* * *

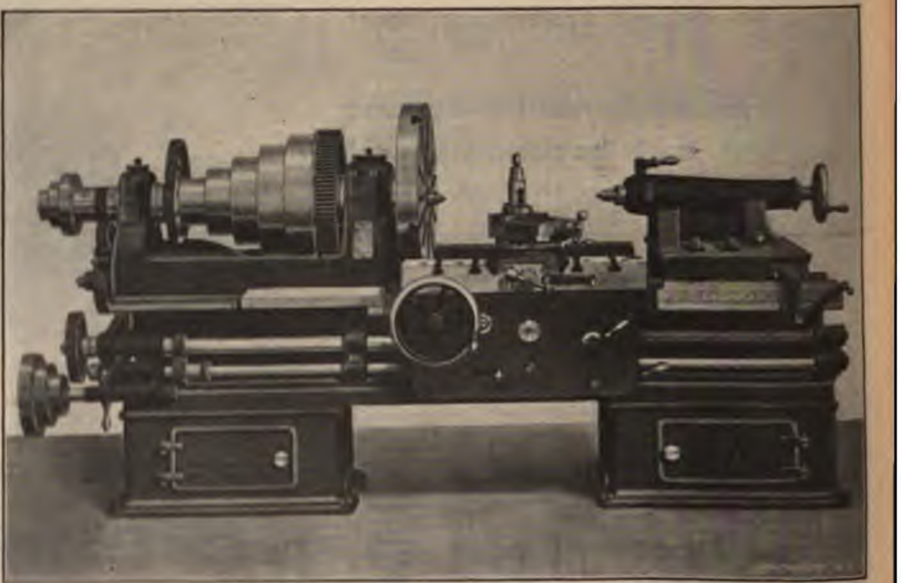
## ADVERTISING LITERATURE.

Wood trimmers is the subject of a catalogue issued by the Fox Machine Co., Grand Rapids, Mich. These trimmers are made in various sizes up to the capacity of cut 24½" long by 8" high.

The Q. & C. Co., Chicago, Ill., have sent us a catalogue of the Torrey Ballast Car, for which they are prepared to grant licenses for manufacturing.

Catalogues have been received from the Cincinnati Milling Machine Co., Cincinnati, Ohio., listing their well known milling machine and also their universal cutter and tool grinder. The latter machine has recently received a number of important improvements.

A handsome and well arranged catalogue has been received from the Bickford Drill & Tool Co., Cincinnati, Ohio. It lists plain radial, half-universal radial, full radial drills; also post drills, suspension drills, multiple drills and special drills for all kinds of work.



New 24-inch Lathe.

## MANUFACTURERS' NOTES.

The New York, Ontario and Western Railroad Company has recently installed in its shops a Duplex Steam Driven Air Compressor built by the New York Air Compressor Company.

A catalogue for 1900 has been received from the Springfield Manufacturing Company, Bridgeport, Mass., manufacturers of special grinding machinery, emery and corundum wheels, etc.

## FRESH FROM THE PRESS.

ıgine Construction, by Henry V. A. Parsell, Jr., and
Weed, M. E., published by Norman W. Henley & Co.,
ıu street, New York. 296 8vo pages, illustrated. Price,

a book intended for amateurs, and as such we can
it. The authors state, "There are many good books
as engine, its theory and designs. There are various
ı mechanical processes; turning, planing, filing, etc.;
o, on how to make model boats, engines, locomotives,
st of mechanical toys, but no really practical book tell-
to make one machine and to make it well. It is with
e points in view that the authors have endeavored to
ımateur in this book, first, a broad and general knowl-
arious forms of gas engines; second, a full and concise
on of the making of a gas engine by practical shop
avoiding makeshifts and bungling; third, a set of modi-
s for designing similar engines, followed by a list of
d periodicals useful to the student."
ok tells at the beginning a few of the important facts,
ated, about the theory of the gas engine. At the end
chapter on design, which, while it contains rules con-
or reference, would hardly form a sufficient guide to
n of a gas engine. The balance of the book is taken
nany half-tone illustrations of patterns and of the pro-
construction for a half horse-power gas engine. It
w a mechanic would perform each one of the machine
rations required in building and erecting the engine.
ost of this instruction would be an old story for a me-
is what an amateur, who usually lacks a knowledge
work, needs.

ess Vehicles, Automobiles and Motor Cycles, by Gard-
iscox, M. E. Published by Norman W. Henley & Co.,
sau street, New York. 458 8vo. pages, illustrated.
.00.

history of the automobile is given in this work, which
ed by descriptions of the numerous automobiles and
or the same that have recently been brought out or
ı the market.
ook is non-technical—that is, it does not enter into
al considerations, nor does it treat of the engineering
of automobile construction and design. The industry of
le construction is not sufficiently advanced, probably,
a strictly technical book of any value to be written
s subject.
ıthor has collected from the mechanical press, from
ports and from information furnished by builders or
through his own personal efforts, over 300 sketches
trations, which, with descriptive matter accompanying
rt of which is evidently clipped, constitute the bulk of
. The division of the subject matter into chapters
possible to refer to any particular subject desired. The
ıe of the book is that it shows what has already been
his industry. It would afford but little assistance other
to the designer. There are a list of automobile patents
ıilders of automobiles at the end of the work.

World's Official Directory of the Textile Manufac-
the United States for 1900. 446 pages. Published by
Lord, publishers of the Textile World, Boston, Mass.
ıen covered edition, $2.00. Price, cloth bound edition,
art I is a directory of the textile manufacturers of the
tates, arranged by states and towns, giving full data of
l, etc. Part II gives a list of the different agents and
textile fabrics. Part III is a directory of the dealers
ıaterials and textile stock. Part IV contains a number
le tables for mill use, such as comparative yarn tables,
les, weight of yarn per yard of cloth table, knitting
zes of yarns for knitting machines, etc.

## MANUFACTURERS' NOTES.

inkley Co., successors to F. D. Winkley & Co., man-
s of dust proof oil-hole covers, have removed their
from Madison, Wis., to Hartford, Conn.

merican Machinery Co., Grand Rapids, Mich., inform
heir exhibit of Oliver Wood trimmers at the M. M. &
convention at Saratoga Springs, New York, was one
teresting exhibits on the grounds. The shaving off of
ving a perfectly smooth end on the wood trimmed was
of surprise and interest to those unfamiliar with Oliver
mmers. An attractive little souvenir booklet entitled
a Chips," of which we received a copy, contained chips
those shaved from the wood at the exhibit.
W. Oliver, president of the company, has left for a
nths' trip abroad, where he will visit the Paris Expo-
d the larger cities of England and the Continent, the
g, we are told, a combination of business and rest.

irteenth annual convention of the officers and agents of
onal Cash Register Co., Dayton, O., has recently been
was made an event of unusual importance in the his-
he company. Representatives were present from dif-
rts of the world at the expense of the company, and the proceedings were attended by the factory employes and their families. The business sessions were interspersed with periods of recreation. Altogether it was a gala event for the company and for the city of Dayton.

The Saginaw Mfg. Co., Saginaw, Mich., have opened a branch house at No. 35 South Canal street, Chicago, Ill. Mr. G. A. Gilbert is manager of this branch, and a complete stock of Gilbert's wood-split pulleys will be carried.

The Bliss Chester Co., Providence, R. I., has recently been organized for the manufacture of sheet-metal stampings, screw-machine products and metal novelties. Mr. M. E. Bliss, of the firm, was formerly with the Mossberg Mfg. Co. Mr. John Chester was connected with the Waterbury Brass Co., and later was superintendent of the Providence Gas Burner Co.

The Philadelphia Machine Tool Co., Philadelphia Pa., call the attention of all interested in the physical testing of materials to their recently added department for the construction of machinery and apparatus employed in such testing. Mr. Joseph W. Bramwell, recently engineer and manager of Riehle Bros. Testing Machine Co. and editor of the "Digest of Physical Tests," will have special charge of this department.

H. W. Johns Mfg. Co.'s new navy brand asbestos fire felt covering has been adopted for the pipe work in the Albany Capitol building of this State. The contract amounts to over $4,000. This company, we are told is making great headway in the way of improvements in the manufacture of their materials. They were also successful in securing the pipe and boiler covering work for the new addition of the Manhattan Hotel, 42nd street and Broadway, New York City.

Harris Machinery Co., Washington avenue, S. E., Minneapolis, Minn., handle all kinds of new and second-hand machinery. We are informed that they will supply anything in the line of engines, boilers, heaters, pumps, piping, shafting, belting, new or second-hand. They have now on hand nearly 1,000 new thresher belts at very reasonable prices.

Mr. Geo. Salzman, who has been tool maker and foreman for the Ball Bearing Co. of Boston, Mass., is now holding a position of foreman of the shops of M. C. Hammett, Troy, N. Y., while Mr. Clarence W. Rowe, general foreman for the Ball Bearing Co., has received and accepted an offer of an important position with the Beloit Iron Works, Beloit, Wis.

Brown & Sharpe Mfg. Co., Providence, R. I., announce that their works will be closed from August 6th to the 18th, inclusive, for the annual vacation and repairs. During the vacation the office will be kept open as usual, and orders for machine tools and small tools, listed in their catalogue, will receive the same attention as at other periods of the year.

We are informed that Mr. A. B. Holmes, who has been connected with the Standard Pneumatic Tool Co., Chicago, Ill., since its organization, has been appointed assistant manager, and will be located at the Marquette Building, Chicago.

The company have also opened offices at Pittsburg, Pa., where their Mr. Wm. Jennings will have complete charge. The president, Mr. Edw. N. Hurley, will sail for Europe on the 30th inst., for the purpose of establishing works in Germany and France for the European trade. Mr. Hurley will also be in attendance at the Paris Exposition.

## ADVERTISING LITERATURE.

We have received the following catalogues and trade circulars:

The S. Obermayer Co., Chicago, Ill., and Cincinnati, O., general catalogue, No. 30, of foundry supplies. Air hoists, cranes, molding machines, blowers, scales, cupolas, and the many other machines and appliances required in the foundry are listed, as well as the supplies that are required in every day work.

Wilmarth & Morman Co., Kalamazoo, Mich., illustrated catalogue of the "New Yankee" drill grinder. A complete line of grinders is listed which will grind all sizes of drills from No. 60 to 5" in diameter. A water grinder and electrically-driven grinder are also made by this company.

The International Correspondence Schools, Scranton, Pa. Two circulars, one containing a large number of home indorsements of this organization and its work; and the other, an interesting story of young men who have fitted themselves for good positions through the work of these schools.

The Gisholt Machine Co., Madison, Wis. A handsomely illustrated catalogue showing both front and top views of their machines. The latter views show the various tools in position in the turret for turning of a varied character. There are also many illustrations of parts that have been made on these machines. The catalogue will prove of interest to the mechanic as well as to the purchasing agent.

The Pratt & Whitney Co., Hartford, Conn. Pocket-size catalogue which illustrates and describes completely the many tools turned out by this firm. There are over 300 pages, and the catalogue will prove handy as a reference book.

The J. M. Carpenter Tap and Die Co., Pawtucket, R. I. Pocket catalogue, No. 13, of tools for cutting screw threads. The manufacturers write that they will be pleased to send this catalogue to any who wish it, and it will be found to contain about everything pertaining to the subject of taps and dies.

The Dwight Slate Machine Co., Hartford, Conn. New pocket-size catalogue of sensitive drills and special machinery. The drills are made both single and multiple spindle, and other tools listed are marking machines, pinion and gear cutters, rack cutter, center grinder, bolt-head milling and screw-slotting machine, cutter and drill grinder, tapping machine, besides numerous small tools and appliances.

Scranton Corundum and Emery Wheel Co., Scranton, Pa. Illustrated catalogue of emery and corundum wheels with safety flanges. A number of grinding machines are also listed.

Beaman & Smith, Providence, R. I. 6" x 9" standard catalogue of milling and boring machines. Milling machines for the heaviest character of work with one or with several spindles are illustrated, and the boring machines include those of the usual horizontal type, besides many floor boring machines for both medium and heavy work. Numerous special machines of this character are included in the catalogue. The designs show much originality and the machines apparently are capable of a wide range of work.

The B. F. Barnes Co., Rockford, Ill., have sent us a catalogue of a 20" upright drill which is of new design and is made either with or without back gears.

Leighton & Wisner, Waltham, Mass. Circular of a new parallel ruler attachment for drawing boards. This ruler is designed to take the place of T-squares, and will rule either horizontal or inclined lines.

Stark Tool Co., Waltham, Mass. Catalogue of machinists' bench lathes, which are designed for both lathe work and milling, and which have numerous attachments for special work. A variety of other small tools are also listed.

FOR SALE.—Bicycle and general repair-shop and small sporting goods store. Established 13 years in Southern Vermont, in village of 4000. Send for description. B. R., care MACHINERY, 9-15 Murray St., New York.

WANTED.—By young mechanical draughtsman and machinist, position as tracer and detailer with a good engine building concern. References given. Address, William R. Williams, Box 433, Mishawaka, Ind.

FOR SALE.—150 H P. Erie Engine in first-class condition, with automatic cut-off, used about one year. Also one large solid iron Pulley, 6 ft. 9 in. diameter, 6 in. hole, 12 in. crown face, keyway, 1 3-16 in. wide, ⅝ in deep. hub 10 in. diameter. Address The Standard Tool Company. Cleveland, Ohio.

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The Meriden Machine Tool Co., Meriden, Conn. A striking circular with advertisements of the forming lathe made by this company, written in imitation of different styles of advertisements used by several well-known manufacturers of popular goods. Like all the circulars of this company, it is out of the ordinary and is interesting reading.

This oil was rank!

But it was all the same to a WARDEN Filter—when it had passed through, the product was clean and clear, like new oil. Don't throw away your dirty oil if it looks worthless, because you are throwing away just that

much clear cash which you might as well save, and in these days of close competition every little counts. Don't waste even a dollar; but save in every department of your business when you can, and the total saved in a year will make a big difference in your profits. Begin the saving with your oil TO-DAY. A WARDEN filter of suitable size will enable you to use it again, no matter how dirty and rank it is; and you needn't risk one cent to try the experiment, for we will send the Filter subject to our guarantee, to be returned at our expense if it doesn't accomplish all we claim—and more.

April 26, 1900.

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GENTLEMEN: We have tested the Filter, running through some of the very rank oil that comes from our spindle borings and automatic screw machines, and find it is all right and you will please forward six (6) more at once as per our understanding.

Very Respectfully,
THE LODGE & SHIPLEY M.T. Co.
Wm. Lodge.

The Burt Manufacturing Co., Main & Howard Sts., Akron, Ohio, U. S. A.

LARGEST MANUFACTURERS OF OIL FILTERS IN THE WORLD.

*The Warden Oil Filter was selected above all others for use in the Power House of the U. S. Machinery Exhibit at Paris.*

FOREIGN AGENTS: Shelby & Co., London, Eng. Alfred Stucken, Moscow, Russia. Gustav Diechmann & Sohn, Berlin, Germany.

| Firm. | Location of Exhibit. | REPRESENTATIVES AT EXHIBITION. | | | | Character of Exhibit and Remarks. |
|---|---|---|---|---|---|---|
| | | In Charge. | Mechanical Experts. | Members of Firm. | When present. | |
| American Machinery Co., Grand Rapids, Mich. | Champ de Mars. Sec. IX.—10.<br>Vincennes. Sec. II.—2. | Alfred Nachtegal.<br>Chas. P. Gage. | | | Entire period. | Oliver Wood Trimmers, for pattern-makers and wood-workers. Sizes 0, 1, 3, 4, 5 and 6. |
| Acme Machinery Co., Cleveland, Ohio. | Champ de Mars.<br>Bois de Vincennes. | A. H. Carpenter. | Louis Durschlag. | A. H. Carpenter, Vice Pres't. | Entire period. | Bolt Heading Machines. Bolt Threading Machines and Nut Tapping Machines. |
| Advance Packing & Supply Co., 55 So. Canal St., Chicago, Ill. | Group IV. Class 19. 1. | | | | | Exhibit of Sample Packings. Requested by Department of Machinery and Electricity. |
| T. R. Almond, 82 Washington St., Brooklyn, N. Y. | | U. S. Commission. | | T. R. Almond. | Aug. 10 to 20. | Almond Drill Chucks and Almond Flexible Electric Light Bracket for electric light purposes. Chucks, 3 sizes—3-16-in., 5-16-in. and 1-2-in. |
| Ambler Asb. Air Cell Covering Co., 26 Cortlandt St., New York. | | | | | | Pipe Covering Asbestos Air Cell and Asbestos Materials. |
| American Steam Gauge Co., Boston, Mass. | Collective Exhibit of American Manufactures. | U. S. Commission. | | J. L. Weeks, Treasurer. | July. | Steam Engine Indicator, with electrical attachments. Reducing wheel, planimeter and other attachments. |
| American Turret Lathe Co., Wilmington, Del. | Vincennes. Spaces 2, 3, 6. Block IX. | L. O. Danse, of Markt & Co., New York. | Wm. Chambers. | C. M. Conradson, Pres't. | July. | 40-in and 24-in Electric-driven, Semi-automatic Turret Lathes. |
| Ashton Valve Co., 271 Franklin St., Boston, Mass. | Champ de Mars. Group IV. Class 19. | Mr. Kiatabian. | | Albert C. Ashton, Sec. & Treas.<br>Fred A. Casey, Vice-Pres't. | April.<br>August. | Ashton Pop Safety Valves, water-relief Valves, cylinder-relief Valves and pressure and vacuum Gages of sizes and styles shown in 1896 catalogue. |
| E. C. Atkins & Co., Indianapolis, Ind. | Champ de Mars. Group II. Class 65.<br>Champ de Mars. Group IV. Class 22. | Robert Ganz and E. S. Taylor. | Edward S. Taylor. | N. A. Gladding. | June 1 to Aug. 1. | Saws. Band, circular, cross-cut, hand, wood and small saws. Saw tools. |
| American Tool & Machine Co., 109 Beach St., Boston, Mass. | | | | | | One 106-in. Belt Knife Leather-Splitting Machine. One No. 2 Improved Turret Lathe. |
| Armstrong Bros. Tool Co., 106-108 W. Washington St., Chicago, Ill. | Block IX. Spaces 2, 4 and 6. | Markt & Co., Ltd., Agents, Paris, France. | | Paul Armstrong, Sec'y. | June 1 to July 1. | Tool holders for lathe and planer work. Drill Grip Sockets. Continuous-acting ratchet drills. |
| Henry Carey Baird & Co., 810 Walnut St., Philadelphia, Pa. | U. S. Commission. | Robert E. Booream, U. S. Commission. | | | | Books on Mining and Metallurgy: Richards' "Aluminum," Brannt's "Metallic Alloys," Mauchlines' "Mine Foreman's Handbook," etc. |
| Baker Bros., Toledo, Ohio. | Vincennes. XIII. | Adolph Janssens. | John Schrag. | | Entire period. | Iron and wood-working machinery. Colburn motor-driven Keyseaters, Nos. 1 and 2. Drill presses, styles F and K. 1 Lag-screw Machine. |
| Ball Engine Co., Erie, Pa. | U. S. Machinery Bldg., Vincennes, Paris. | W. F. Treiber. | W. F. Treiber. | | Entire period. | Automatic cut-off Tandem Compound Engine; direct connected. 200 kw. Bullock generator. |
| W. T. & Jno. Barnes Co., Rockford, Ill. | Champ de Mars. Space 1. Block V.<br>Vincennes. Space 5. Block II. | Fenwick Frères, Paris. | | | | Upright Drilling Machines. |
| Batcheller Pneumatic Tube Co., Tribune Bldg., New York. | Champ de Mars. Block V. Space 1. Group IV. Class 21. | B. C. Batcheller. | Frank McCluskey. | John E. Milholland, Pres't.<br>J. F. Montegnani, Vice-Pres't.<br>Geo. J. Murray. | | 8-in system (of 1,000-ft.) of pneumatic tube. Pipe 8 in. diam., 1,000 ft. in length. One Transmitter, 1 Receiver, Pipe, Switches and Brass Bends. |
| Becker-Brainard Milling Machine Co., Hyde Park, Mass. | Champ de Mars. Groups IV. and V.<br>Vincennes. Block V. Space 5. | Roux Frères et Cie, Paris<br>Ad. Janssens. | John Becker. | | June and July. | Milling Machines. Gear Cutting Machines—One each Becker Vertical Milling Machines—Nos. 5B, 3 and 2 1-2; one No. 3 Horizontal Standard. One No. 18 Gear Cutting Machine. |
| The Bickford Drill & Tool Co., Cincinnati, Ohio. | Champ de Mars. Space 9.<br>Vincennes. Space 13. | A. Janssens, Paris, France. | | H. C. Hoefinghoff. | | Mars—Nos. 0 and 1 Radial. Vincennes—Nos. 0 and 1 plain Radial. No. 2 Full Universal Radial. 4 Spindle Multiple Drill. 4 Spindle Gear Cutter. |
| Hugo Bilgram, N. W. Cor. 12th and Noble Sts., Philadelphia, Pa. | | U. S. Commission. | | | | Bevel Gears and some Modifications. |
| Billings & Spencer Co., Hartford, Ct. | Champ de Mars.<br>Vincennes. | Fenwick Frères, Paris. | | | | Drop Forgings. Machinists' Tools—Screw plates, dogs, wrenches, hammers, clamps, drivers, etc. |
| E. W. Bliss Co., Brooklyn, N. Y. | Vincennes. Block I. Space 3.<br>Champ de Mars. Block VIII. | A. Wilzin. | A. Wilzin.<br>J. A. Seitz. | | | Sheet Metal Working Tools. Armature Disc Notching and Blanking Tools. Presses, Dies and Special Machinery. |
| Bowen Mfg. Co., Auburn, N. Y. | Champ de Mars. | U. S. Commission. | | Geo. W. Bowen. | June 1 to Sept. 1. | Oil Cups and Felt Washers for machinery, Automobiles, Electric Fans, etc. |
| Bradford Machine Tool Co., Cincinnati, Ohio. | Vincennes. | Markt & Co., Ltd., Paris. | | Geo. F. Stewart, Pres't. | | Engine Lathes with taper attachment. |
| Randolph Brandt, New York. | Champ de Mars. | U. S. Commission. | | | | Selden Patent Packing, etc. |
| Bristol Company, Waterbury, Conn. | | U. S. Commission. | | | | Recording Pressure Gauges, Voltmeters, Ampere Meters and Thermometers. |

| Firm. | Location of Exhibit. | REPRESENTATIVES AT EXHIBITION. | | | | Character of Exhibit and Remarks. |
|---|---|---|---|---|---|---|
| | | In Charge. | Mechanical Experts. | Members of Firm. | When present. | |
| Bement, Miles & Co., Philadelphia, Pa. | Champ de Mars.<br>Vincennes. | Fenwick, Freres & Co. | Fred. C. Woodrough | | | No. 9 Vertical Milling Machine. 1100 lbs. Single Frame Steam Hammer.<br>No. 1 Cotter Drill and Keyseating Machine.<br>79-in. Double driving wheel Lathe. No. 3 Horizontal Boring and Drilling Machine. One 16-in. Slotting Machine. |
| Brown & Sharpe Mfg. Co., Providence, R. I. | Vincennes: Block III.; Space 2; Champ de Mars, Block A, Space 1; Palace Liberal Arts, Block A, Space 5. | G. H. Merryweather. | E. H. Parks, M. E. | | | Machine Tools—Small and Measuring Tools. Milling Machines, Grinding Machines, Screw Machines, Gear Cutters, Rules, Scales, Calipers, etc. |
| Builders' Iron Foundry, Providence, R. I. | Vincennes. Block IV. Space 4.<br>Champ de Mars. Block IV. Space 1. | Fenwick Frères, Agents, Paris. | | | | Grinding and Polishing Machinery. |
| Bullard Machine Tool Co., Bridgeport, Conn. | Champ de Mars. Block IV. Space 1.<br>Vincennes. Block IV. Space 3. | E. P. Bullard, Jr. | E. P. Bullard, Jr. | E. P. Bullard, Jr., and E. P. Bullard. | | Machine Tools. Boring and Turning Mills. Turret Machines. |
| Bullock Electric Mfg. Co., Cincinnati, Ohio. | Champ de Mars. Block XIII.<br>Vincennes. Sec. 4. | Société l'Electra, Paris.<br>Bergtheil & Young, London, Eng. | Mr. Breitmayer.<br>Max Touret. | George Bullock, Pres't. | Representative entire period. | Electrical Machinery—11 Motors or Generators and accessories. Two Motors. 1 Generator for furnishing power. |
| M. C. Bullock Mfg. Co., Chicago, Ill. | Vincennes. | Harold Hart. | | | | Diamond-Pointed Prospecting Core Drills, from 300 ft. to 3,000 ft. capacity. |
| The Carborundum Company, Niagara Falls, N. Y. | Champ de Mars. | U. S. Commission. | | | | Abrasive articles made from carborundum. |
| J. M. Carpenter Tap & Die Co., Pawtucket, R. I. | | Adolphe Janssens, Paris. | | | | Taps and Dies of general sizes. Rd Die Stocks, Taps, Wrenches and Screw-Plates. |
| Chapman Valve Mfg. Co., Indian Orchard, Mass. | Champ de Mars. Block II. Space 5. | Roux Frères et Cie, Paris. | | | | Valves for water, gas, steam, ammonia, oil, acid, etc. |
| Cincinnati Milling Machine Co., Cincinnati, Ohio. | Champ de Mars. Block IX. Space 7.<br>Vincennes. Block VIII. Space 4. | Fred. Holz, Jr. | Fred Holz, Jr. | Fred Holz, Sr.<br>Fred Geier. | June.<br>May. | Full line Milling Machines, plain and universal, with attachments. Universal Cutter and Tool Grinders. |
| Cleveland Twist Drill Co., Cleveland, Ohio. | Champ de Mars. Block VIII. Space 4. | Fenwick Frères, Paris. | | | | Twist Drills, Reamers, Oil Tube Drills, Socket Cutters, etc. |
| Crescent Steel Co., Pittsburg, Pa. | Champ de Mars. | Albert L. Butler. | L. J. Laureau. | | | Steel by the crucible and special processes, and illustrative specimens showing application in the arts. |
| Curtis & Curtis, Bridgeport, Conn. | Champ de Mars.<br>Vincennes. | Adolphe Janssens, Paris.<br>Sussfeld, Lorsch & Co., Paris. | | | | Pipe Cutting and Threading Machine. One 2 1-2 in. to 4-in. Pipe Cutting and Threading Machines. One 1-4 in.; 2 Hand Machines; one 1 in.; 4 in. hand and power Machines. |
| Crane Company, Chicago, Ill. | Champ de Mars. Group IV. Class 19. | John C. Kilgore. | John C. Kilgore. | Charles R. Crane, Vice Pres't.<br>A. D. MacGill, Ass't Treasurer. | June.<br>August. | Brass and iron Valves and Cocks.<br>Cast and malleable iron fittings, for ordinary and extreme high pressure. Engine Trimmings—Steam and Gas Fitters' Tools. Sizes 1-8 in. to 8 in. |
| Chicago Pneumatic Tool Co., 635 Monadnock Bldg., Chicago, Ill. | Champs de Mars. Groups IV. and V.<br>Vincennes. Group IV. Space 1. | Taite, Howard & Co., London.<br>Glaenzer & Perreaud, Paris. | | J. W. Duntley, Pres't.<br>J. F. Duntley, Vice-Pres't. | Part June & July.<br>August. | Pneumatic Hammers, Drills, Riveters, Stay Bolt Nippers and Cutters, Flue Welders and Expanders, Air Compressors. |
| D'Amour & Littledale Machine Co., 129 Worth St., New York. | Champ de Mars.<br>Vincennes. | Markt & Co. | | | | Sensitive Drill Presses. 4 Spindle 14-in. Sensitive Drill—Single Spindle 14-in. Sensitive Drill-Tapping attachment for 14-in. Drills. |
| Herman Dock, 904 N. Broad St., Philadelphia, Pa. | | Warren E. Weinsheimer. | | | | No. 1 Centre Grinders for Lathes, up to 40-in. |
| Eagle Oil & Supply Co., 104 Broad St., Boston, Mass. | | | | Clarence N. Goward, Pres't.<br>T. James Babcock, Sec. & Treas. | Third week after opening. | Oils. |
| F. A. Errington, 39 Cortlandt St., New York. | Champ de Mars.<br>Vincennes. | U. S. Commission.<br>Adolphe Janssens. | W. E. Weinsheimer. | | Entire period. | Nos. 0 and 1 Auto-Reverse Tapping Chucks. No. 2 Auto-Reverse Drill Press Turret. |
| J. A. Fay & Egan Co., Cincinnati, Ohio. | Champ de Mars. Block XIV. Space 3.<br>Vincennes. Block XIV. Space 2. | G. P. Altenberg. | G. P. Altenberg.<br>Clifford P. Egan. | Thos. P. Egan | T. P. Egan, July 1<br>G. P. Altenberg.<br>Clifford P. Egan: Entire time. | Wood-working Machinery. All styles of machines for working and cutting wood. |
| Fellows Gear Shaper Co., Springfield, Vt. | Champ de Mars. Block XV. Space 10.<br>Vincennes. Block VI. Space 2. | Wm. B. Murdock. | | | | Gear Shaper and Cutters. 36-in. Gear Shaper. |
| Ferracute Machine Co., Bridgeton, N. J. | Champ de Mars. Main Exhibit.<br>Vincennes.<br>Government Space. | Read Elmer.<br>Chas. Drolet.<br>Percival H. Smith. | | Oberlin Smith, Pres't.<br>Fred F. Smith, Sec'y. | May or June.<br>Apl. 1 to May 25; in Oct. & Nov. | Presses for cutting, punching, drawing, embossing, coining, milling, stamping, etc. Sheet Metal Presses weigh from 250 to 16,000 pounds. |
| Flather & Co., Nashua, N. H. | Champ de Mars. Block X. Space 2. | | | Joseph Flather.<br>Wm. J. Flather. | April.<br>June to Sept. | Engine Lathes.—One 15-in. Engine Lathe; one 26x10; one 20x8; one 16x6. |
| Mark Flather Planer Co., | Vincennes. Block VIII. Space 3. | Adolphe Janssens. | | Mark Flather. | Sept. till close | Planers and Shapers—One 18-in. Shaper; one 27x27x6 |

| Firm. | Location of Exhibit. | REPRESENTATIVES AT EXHIBITION. | | | | Character of Exhibit and Remarks. |
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| | | In Charge. | Mechanical Experts. | Members of Firm. | When present. | |
| Stow Mfg. Co., Binghamton, N. Y. | Champ de Mars. | U. S. Commission. | | C. F. Hotchkiss, Pres't. | | One Centre Grinder, one Combination 1-2 H. P. Multi-Speed Electric Motor and Stow Flexible Shaft for portable drilling, tapping, reaming, etc. |
| Robert J. Stuart, New Hamburgh, N. Y. | Champ de Mars. | F. E. Drake. | | | | One 2-in. Compression Wedge Coupling. |
| Taunton Locomotive Mfg. Co., Taunton, Mass. | Vincennes. | U. S. Commission. | | | | One Wainwright Water Tube Feed Water Heater, 300 H. P. |
| Trimont Mfg. Co., Amory St., Roxbury, Mass. | Champ de Mars. Groups IV. and V. | F. E. Drake. | | | | Plumbers' and Steamfitters' Tools. Pipe Wrenches and Pipe Cutters. |
| Trump Bros. Machine Co., Wilmington, Del. | Champ de Mars. | F. E. Drake. | | | | One Lathe Centre Grinder. |
| Vacuum Oil Co., Rochester, N. Y. | Champ de Mars. | Vacuum Oil Co., S. A. F., Paris. | | | | Oil and Grease Samples. Leather oils and greases. |
| Veeder Mfg. Co., Hartford, Conn. | Champ de Mars. | Markt & Co. | | C. H. Veeder, Pres't.<br>D. J. Post, Treas. | | Cyclometers and Counters. |
| Waterbury Tool Co., Waterbury, Conn. | Champ de Mars. U. S. Collective Exhibit.<br>Vincennes. U. S. Collective Exhibit. | Warren E. Weinsheimer. | | | Entire period. | Williams Universal Ratchet Drills. New motion. Handle movable in any direction. |
| Watson-Stillman Co., New York. | | U. S. Commission. | | | | One Open-jaw Die Sinking Press. One 7-ton Swivel Claw Hydraulic Jack. |
| J. H. Williams & Co., 9 Richard St., Brooklyn, N. Y. | Champ de Mars. | Wm. C. Redfield. | | Wm. C. Redfield, Treas. | Entire period. | Drop Forgings. Special Tools. Pipe and Machine Wrenches. Drop-forged appliances. |
| Westcott Chuck Co., Oneida, N. Y. | Champ de Mars. Groups IV. and V. | Markt & Co., Paris. | | | | All styles and sizes of Chucks for iron-working machines. |
| Warner & Swasey, Cleveland, Ohio. | Champ de Mars. Groups IV. and V.<br>Vincennes. Group IV. Space 1. | Wm. E. Reed. | E. E. Winship. | Ambrose Swasey.<br>W. R. Warner. | May 1 to June 1.<br>Aug. 1 to Sept. 1. | Machine Tools. Iron and brass-working machinery. Turret Machinery. |
| Western Electric Co., Chicago and New York. | Champ de Mars. | J. M. Hollister. | | | | Appliances for telephone, telegraph, fire alarm, electric lighting and power transmission. |
| Whitman & Barnes Mfg. Co., Akron, Ohio. | | James S. Duncan. | Walter Butler. | Geo. E. Dana, Pres't. | | Mowing and Reaping Machines. Knives and Sickles, Twist Drills, Milling Cutters and Reamers, etc. |
| F. D. Winkley, Madison, Wis. | Champ de Mars. | U. S. Commission. | | F. D. Winkley, probably. | | Oil hole Covers. |
| Walworth Mfg. Co., 122 Federal St., Boston, Mass. | Champ de Mars. | H. Munzing. | | Geo. T. Coppins, Sec'y. | | Steam users' materials and tools for steam, gas and water work. |
| La Societe Industrielle d'Electricite, Procedes Westinghouse. | Exhibition Grounds. Near Eiffel Tower. | A. Schmidt.<br>M. Coster. | Max Nelder. | | Entire period. | Two 850 H. P. type "C" Induction Motors, direct-connected; two 600 K. W., direct-current generators; 150 direct-current motors operating moving platform. |
| Westinghouse Brake Co., Ltd. | Vincennes. | J. W. Cloud. | G. Trube. | | Entire period. | Westinghouse Air Brakes Electro-Pneumatic Switch and signal systems. |

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# MACHINERY:

VOL. 6. NO. 1.

PUBLICATION OFFICE
9-15 MURRAY STREET
NEW YORK CITY.

SEPTEMBER, 1899.

A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS
AND FOR ALL WHO ARE INTERESTED IN MACHINERY:

**Drilling and Boring Machinery.**

We are equipped to build the best of their class—everything modern and complete. The best of materials and first-class workmanship. This entire plant is devoted to the manufacture of Drilling and Boring Machinery of which we make a specialty. Correspondence solicited.

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WM. BAUSH, TREASURER AND GENERAL MANAGER.
GEO. H. BAUSH, VICE PRESIDENT AND SUPERINTENDENT.

**Baush & Harris Machine Tool Company,**
SPRINGFIELD, MASS., U. S. A.

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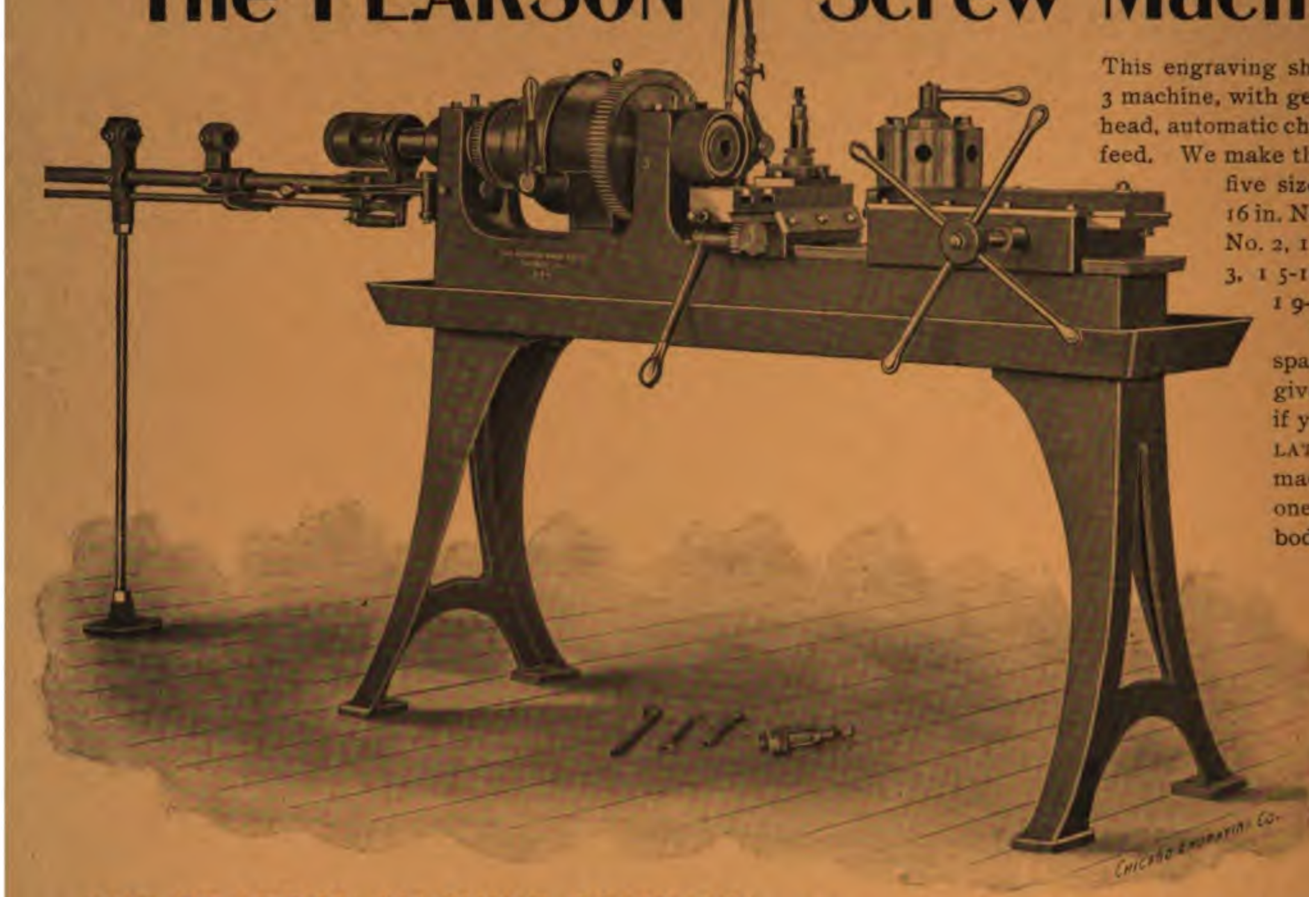
# The PEARSON Screw Machine


CHICAGO ENGRAVING CO.

This engraving shows our No. 3 machine, with geared friction head, automatic chuck and wire feed. We make these tools in five sizes; No. 0, 9-16 in. No. 1, 13-16 in. No. 2, 1 1-16 in. No. 3, 1 5-16 in. No. 4, 1 9-16 in.

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**Cable, "Pearson," Chicago. Lieber's Code.**

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Gustav Diechmann & Sohn, Berlin. B. A. Hjorth & Co., Stockholm.

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## FOR IRON AND STEEL.

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A FULL LINE FOR ALL PURPOSES.

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Catalogues sent free.

*J. E. SNYDER, Worcester, Mass., U. S. A.*

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You might have a perfect machine, but your gears would be "out" as much as your cutter, and unless your cutter is ground after it is hardened, it is certainly "out."

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The Fellows Gear Shaper Co.

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**WILLIAMS' WRENCHES** are supplied in four conditions: Unfinished—plain forgings; Unfinished—milled—jaws milled, otherwise unfinished; Semi-Finished—jaws milled, case-hardened all over; Finished—milled, ground, polished, case-hardened all over.

*Note.—The semi-Finished, practically unbreakable, differ from the Finished only in that they lack grinding and polishing, and, at lower price, make a most economical wrench.*

**Ask for Catalog B,**

which shows a variety of other machinists tools.

And now a word about

**DROP-FORGINGS.**

We enjoy making special parts for lathes, presses, steam pumps, engines, motors, special tools, etc., from Tobin Bronze, Copper, Iron, Steel, and Aluminum. Big plant, skilled workman, and

**PROMPT DELIVERIES.**

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*Betts Machine Company,*

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*MACHINE TOOLS*

*OF THE MOST ADVANCED TYPES.*

*PLANERS.—3 ft. to 10 ft. square.*
*SLOTTERS.—8 in. to 24 in. Stroke.*
*BORING AND TURNING MILLS.—5 ft. to 20 ft.*
*HORIZONTAL BORING AND DRILLING MACHINES.—Usual sizes.*

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**Fillet Cutter.**

Double Ended Reversible Knife cuts Fillet any size or shape required. Should be in every Pattern Maker's Tool Box.

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(Successors to D. Fraser Mfg. Co. and Eagle Pattern Works),
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OF EVERY DESCRIPTION.

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SEND FOR CATALOGUE
WARRANTED

**BOLT THREADERS HEADERS and ≡NUT≡ TAPPERS.**

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Cleveland, O., U. S. A.
Office, 1125 Hamilton Street.

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FOR PIPE.

**Machinists, Engineers,**
**Steam and Hot Water Fitters,**
**Millmen, Mechanics Generally**

Are urged to look into the merits of our celebrated

**"Duplex" Adjustable Die Stocks.**

FOR BOLTS.

**They have no Equals.**

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One Coat Loom Enamel.

**. . . Cuts the Paint Bill in Two . . .**

Covers solidly in one coat and dries with brilliant gloss so that machines coated with it can be shipped in three to six hours.

Saves 50 per cent. of labor, material and time. No varnish required. Equally well adapted for all machinery. Single gallons at $1.40; cases of 12 one gallons, $1.25 per gallon. Send for color card.

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SAVE YOUR OIL

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Requires no skilled attendant.

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Shapers,
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Power Presses.

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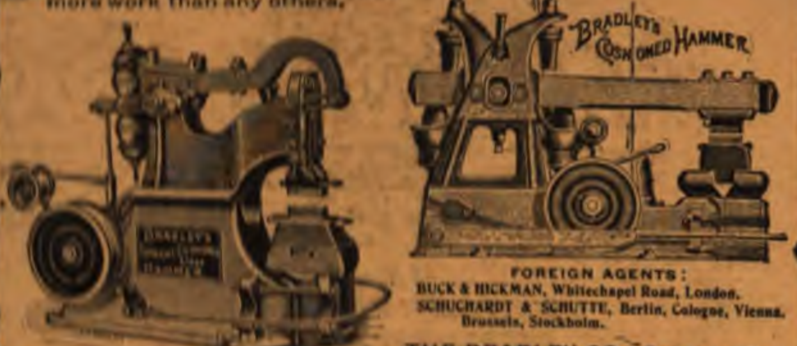

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FULL THREAD AT ONE CUT
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Our Hot Forged Twist Drills will do one-third more work than a milled drill. We have convinced others; let us convince you.

ACCURATE,
DURABLE,
HIGHLY
FINISHED.

NEW PROCESS TWIST DRILL COMPANY, TAUNTON, MASS., U. S. A.

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FRANK BURGESS, Prop. 40 Hartford St., BOSTON, MASS.
3,200 sizes Spur, Bevel, Spiral, Worm, Sprockets, Rack, Elliptic, Internal, etc.
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BEVEL GEARS WITH PLANED TEETH.

Boring and Turning Mills.

4, 5 AND 6 FOOT SWING.

*Send for photograph and low prices.*

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STRAIGHT OR BEVELED INTERNAL GEARS. ANY SIZE

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TWELVE MEDALS awarded at INTERNATIONAL EXPOSITIONS.

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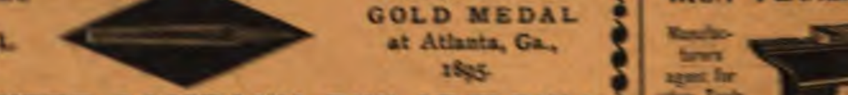

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THE ONLY CORRECT GEAR-CUTTER GRINDER MADE.

IT GRINDS CUTTERS RADIALLY & EQUI-DISTANT DELUGING THEM IN WATER.

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Ready Made Gears.
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Treatise on Gears, $1.00. Catalogue Free.
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Grinding Machines.

The Tanite Co.,
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THE J. M. CARPENTER TAP & DIE CO.
PAWTUCKET, R. I., U. S. A.
Manufacturers of Tools for Cutting Screw Threads.

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TRADE [illegible] MARK

DOMESTIC EDITION.
ADV. INDEX PAGE 11.

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DOMESTIC EDITION.
ADV. INDEX PAGE 11.

# MACHINERY:

VOL. 6. NO. 2.

PUBLICATION OFFICE
9-15 MURRAY STREET
NEW YORK CITY.

OCTOBER, 1899.

## A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS AND FOR ALL WHO ARE INTERESTED IN MACHINERY:

*High-Carbon Crucible Steel;*
*Hard, Thorough Temper;*
*Sharp, Strong Teeth;*
*Uniform.*

**Famous**
for
**Temper and Cut.**

**NICHOLSON**
**FILES.**

*5 Brands.*
*5 Factories.*

*76,800 Daily Production.*

**Nicholson File Company,**
PROVIDENCE, R. I., U. S. A.
Sam'l M. Nicholson, Pres't and Gen. Mgr. Largest Makers in the World.

**Sold**
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**Every Important City**
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**World.**

*Our*
CATALOGUE,
*450 illustrations,*
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FILE FILOSOPHY,
*Telling all about Files and how to use them, are sent* FREE *on request. They make a complete study and are indispensable to users.*

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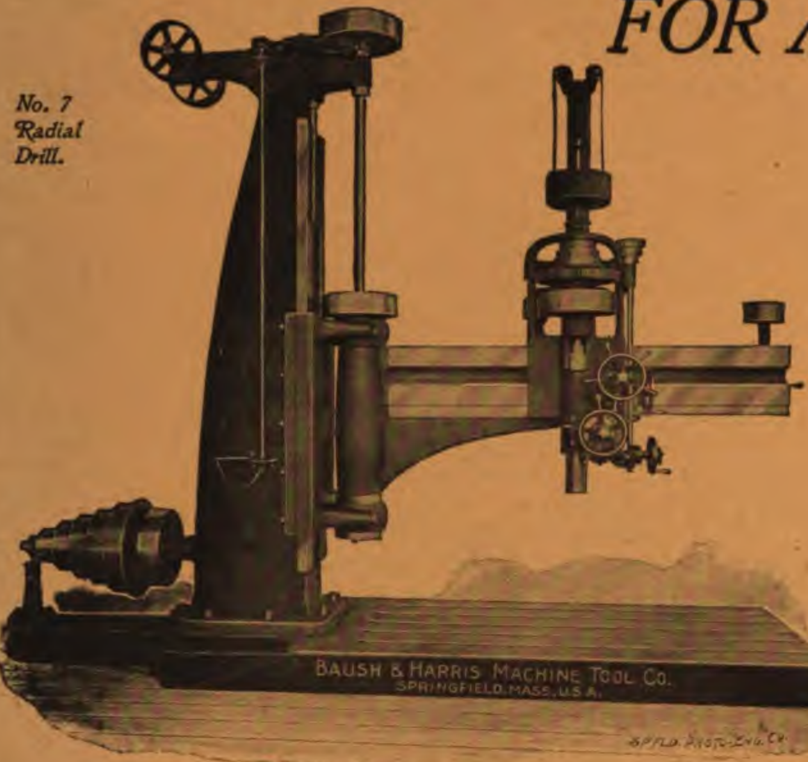
## FOR ALL PURPOSES.

*3 ft. to 14 ft. Swing.*

*No. 7 Radial Drill.*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**PUNCHES AND DIES.**

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**Testing Machines.** Arthur V. Abbott. 50 cents Gives a good idea of testing machines and useful information concerning them. Sent post paid, for two NEW subscribers, or the book and one subscription for $1.20. MACHINERY, 9-15 Murray St. New York.

HIGH GRADE

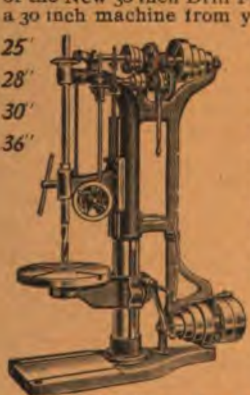
**Vertical Drilling Machinery**

ROCHESTER, N. Y., Sept. 25, 1897.

J. E. SNYDER, Worcester, Mass.

Dear Sir:—Yours of the 22d is at hand and noted. Enclosed find our check in settlement of the New 36 inch Drill Press. We purchased a 30 inch machine from you several years ago and were so highly pleased with it that when we decided to purchase another we were pleased to find that you had introduced several new features and improvements and we decided to place our order with you for the same. It gives us pleasure to state that it is first-class in all its details, quick and convenient to operate and adjust, and accurate in its production. We are more than pleased with it and you are at liberty to refer to us at any time.

Very truly yours,
THE J. S. GRAHAM MACHINE CO.
JOHN KANE, Vice-Pres.



**J. E. SNYDER,**
*Worcester, Mass., U. S. A.*

## The Fellows Gear Shaper

is not an experiment. Two years of test has proved that it is not only theoretically correct, but is practically the most efficient gear cutter on the market. Ask the

FELLOWS GEAR SHAPER CO.,

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WE MAKE
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## Shapers

Four sizes of this style, 12, 16, 20, 25 inches, with all the desirable features.

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**WILLIAMS DROP-FORGINGS**

**Economy:**

n. *The art of saving money by using Williams' Drop-Forgings.*
*Williams.*

**Drop-forgings**

so close to size as to require the minimum of finishing. Often, only a file finish is necessary.

**"Quality"**

is our watchword. Every forging is carefully inspected before it leaves our works, faulty ones are thrown out, and you pay for no "wasters." We employ expert labor and use modern machinery. We drop-forge Tobin Bronze, Copper, Iron and Steel. Prices not too high. Send drawings for estimate.

TRADE MARK W

**WILLIAMS** Drop-Forged
**WRENCHES.**
Preferred by good mechanics.
ASK FOR CATALOG B.

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PAUL M. WADE, MECHANICAL ADVERTISING, N. Y.

DOMESTIC EDITION.
ADV. INDEX PAGE 11.

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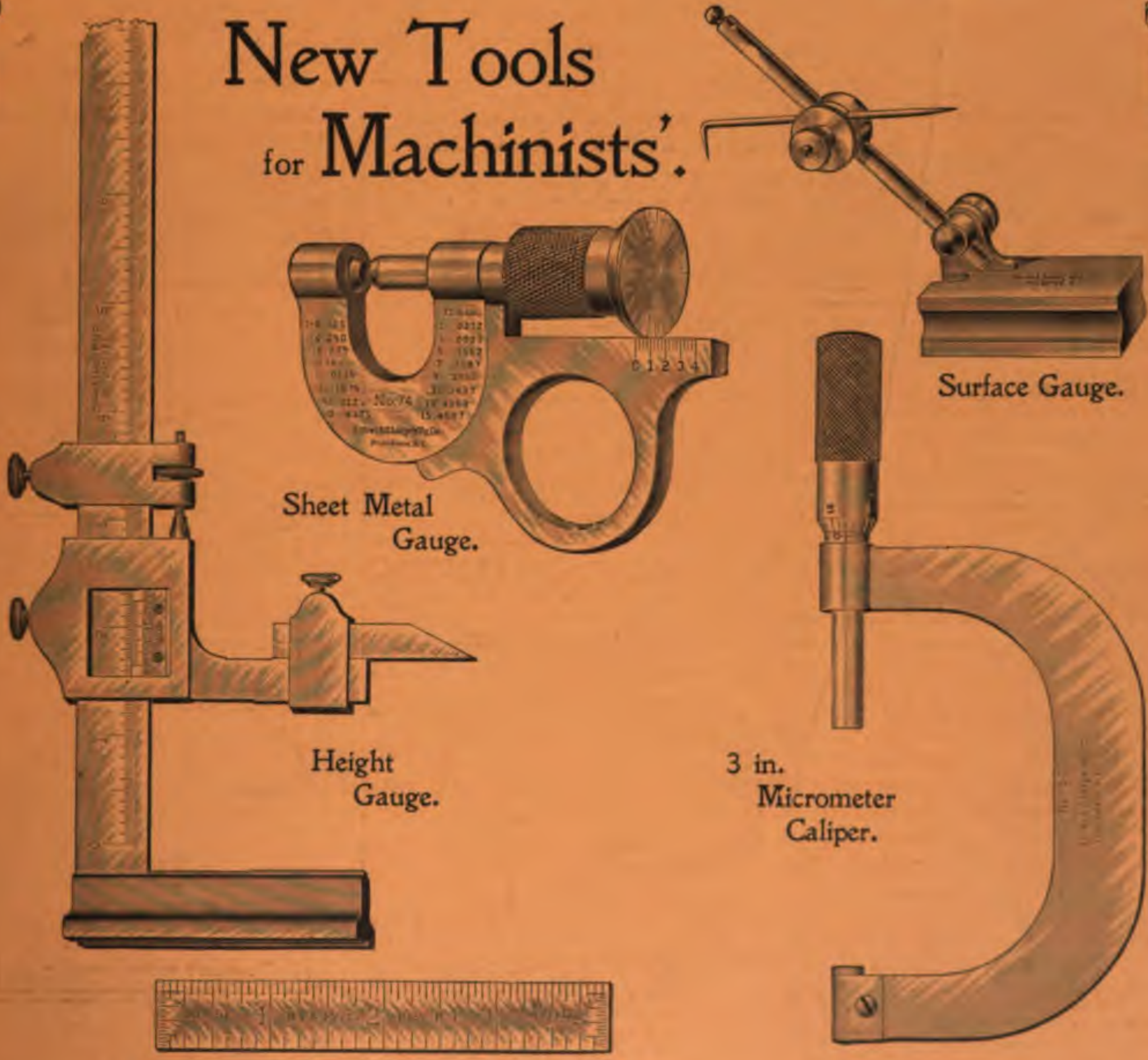
# MACHINERY:

VOL. 6. NO. 3.
PUBLICATION OFFICE
9-15 MURRAY STREET
NEW YORK CITY.
NOVEMBER, 1899.

## A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS AND FOR ALL WHO ARE INTERESTED IN MACHINERY:

**Brown & Sharpe Mfg. Co.,** Providence, R. I.,
U. S. A.

### New Tools for Machinists'.



Surface Gauge.

Sheet Metal Gauge.

Height Gauge.

3 in. Micrometer Caliper.

Tempered Rules with End Graduations.

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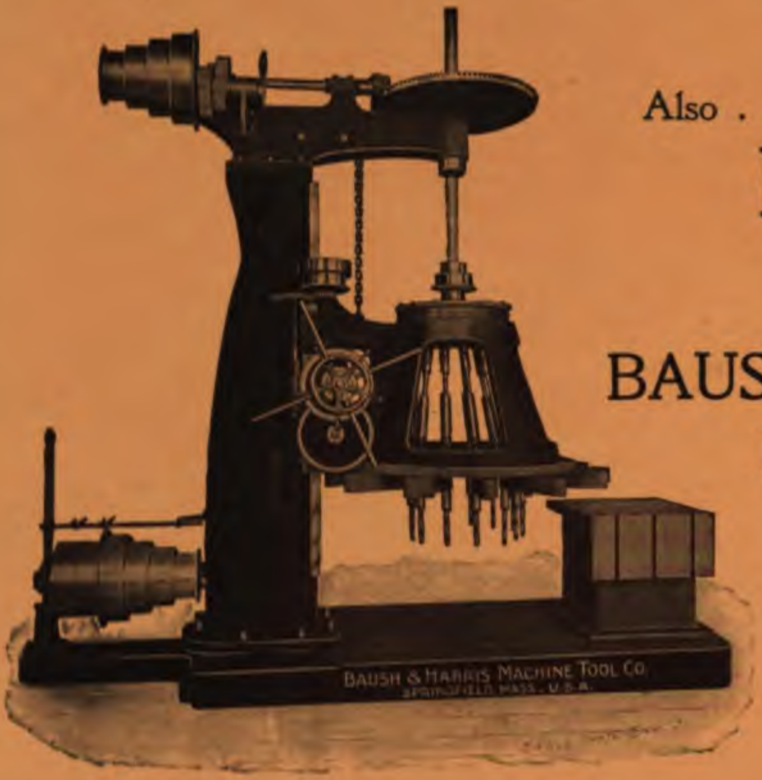
4 TO 24 SPINDLES.



12 SPINDLE DRILL.

Also . . . .

## Radial Drills

For Every Purpose.

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Berlin, Germany.

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## PUNCHES AND DIES.

**FOR IRON AND STEEL.**

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**Testing Machines.** Arthur V. Abbott. 50 cents. Gives a good idea of testing machines and useful information concerning them. Sent, post paid, for two NEW subscribers, or the book and one subscription for $1.20. MACHINERY, 9-15 Murray St., New York.

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HIGH GRADE

## Vertical Drilling Machinery

20"
21"
25"
28"
30"
36"

*It is an easy matter for every manufacturer to praise his own goods, but the consumer will not do this unless there is positive proof that the goods are as represented. Hear what some of our customers say. We prefer to let you hear their side of the story.*

WORCESTER, MASS., Jan. 14, 1901.

MR. J. E. SNYDER, Worcester, Mass.

Dear Sir:—In the equipment of our shop we included three of your Upright Drills, a 25 in., a 28 in., and a 36 in. This choice was the result of some observation on our part, and the result fully justifies the choice. Our opinion in a nut shell is, they are of the highest class in every respect.

Yours very truly,
WHEELOCK ENGINE CO.
EDWARD K. HILL, Gen'l Manager.

*J. E. SNYDER, Worcester, Mass., U. S. A.*

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## IT'S THE CUTTER THAT DOES IT.

**You might have a perfect machine, but your gears would be "out" as much as your cutter, and unless your cutter is ground after it is hardened, it is certainly "out."**

**We grind the tooth form of our cutter after it is hardened.**

The Fellows Gear Shaper Co.

Springfield, Vermont.

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**HIGH GRADE** **SHAPERS**

This is our Triple Geared Shaper, made in four sizes, 20, 24, 28 and 32 inches. Embodying the latest mechanical improvements in these tools.

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Sole European Agents, Selig, Sonnenthal & Co.,
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## WILLIAMS
## Drop-forged
## WRENCHES

**WRENCH-OLOGY:**

*n. The art of making drop-forged wrenches.*

*Williams.*

It would wrench our feelings to hear of one purpose for which we cannot supply a wrench. Wrenches for the engine, the pump, the lathe, the press, the ice machine, the motor, the railway car, the track, etc., etc. Imagine for yourselves a line of over 185 sizes and styles! And then conjure up over 100,000 in stock! Our Semi-Finished has jaws milled and is case-hardened all over, yet sells at a price that is—investigate! ("A word to the wise.")

Quality guaranteed.

**Ask for Catalogue B.**

Ever tried the VULCAN CHAIN PIPE WRENCH?

TRADE MARK
W

**WILLIAMS' DROP-FORGINGS.**

"QUALITY PERSONIFIED."

J. H. WILLIAMS & Co.,
9-31 RICHARDS STREET,
BROOKLYN, NEW YORK.

DOMESTIC EDITION.—ADVERTISING INDEX PAGE 19.

Cairns

# MACHINERY:

VOL. 6. DECEMBER, 1899. No. 4.

PUBLICATION OFFICE 9-15 MURRAY STREET NEW YORK

## A PRACTICAL JOURNAL FOR THE MACHINE SHOP.

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*In dull times...*

*The Flat Turret Lathe*

was sold on its cost reducing features,—more than half of the machines being sold on a guarantee to save over $1200.00 per year.

In these prosperous times buyers ask for ***Flat Turret Lathes*** because these machines greatly increase the output of a plant per man.

You know the importance of increasing your output; you also know that the time may come when you will wish you had installed cost reducing machinery.

You may now be running several of these machines, and have forgotten that there are yet many pieces of work that could be turned out at a great saving if you only had a few more ***Flat Turret Lathes.***

We will quote you the same price now that we did in hard times, and will give you an exact date on which your machine will be shipped.

Good times are almost guaranteed to last, at least, one year more, and in that time one more of these machines will save in actual shop cost more than its first cost, to which can be added the increase in profit due to increase in output, making the purchase a handsome investment.

Made in one size only. Capacity 2 in. in diameter when working from full length bars, and almost any diameter up to 16 in. when working from forgings. Any piece of work from a washer ⅛ in. thick to a shaft 24 in. or 36 in. long.

The outfit of tools furnished with the machine turns and threads all diameters from 2 in. down, and all lengths under 24 in.

*Jones & Lamson Machine Company,*
*Springfield, Vermont, U. S. A.*

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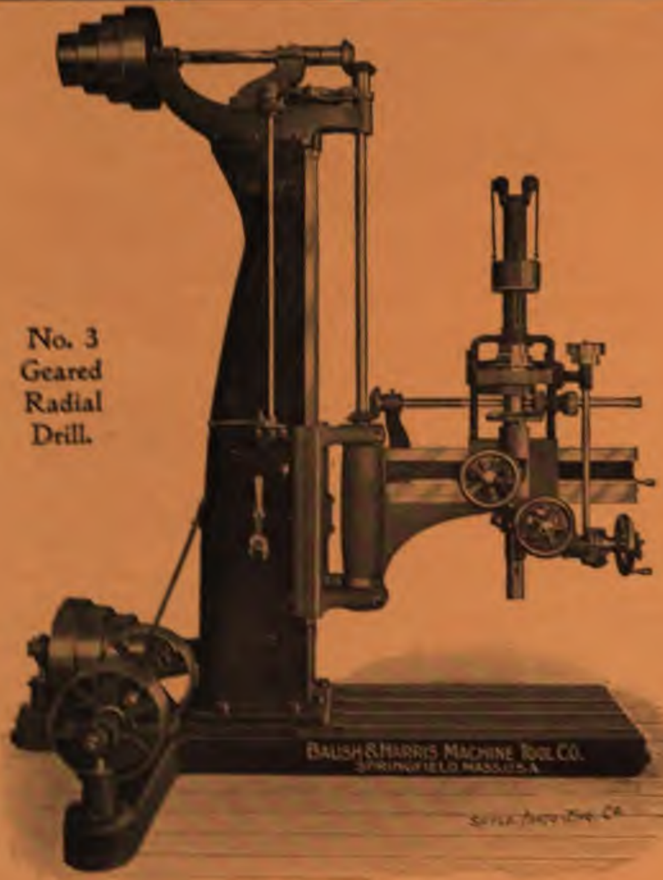
HENRY KELLEY & CO., 26 Pall Mall, Manchester.
GERMANY, HOLLAND, BELGIUM, SWITZERLAND and AUSTRIA-HUNGARY: M. KOYEMANN, Charlottenstrasse, 112, Düsseldorf, Germany.
FRANCE: Ph. Bonvillain, 6, Rue Blanche, 6, Paris.

# RADIAL DRILLS . . .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Drill.

## LARGE OR SMALL,
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**PUNCHES AND DIES.**

**FOR IRON AND STEEL.**

## TAPS AND DIES

OF EVERY DESCRIPTION.

**BUTTERFIELD & CO.,**

DERBY LINE, VERMONT, and ROCK ISLAND, CANADA.

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HIGH GRADE

## Vertical Drilling Machinery

*It is an easy matter for every manufacturer to praise his own goods, but the consumer will not do this unless there is positive proof that the goods are as represented. Hear what some of our customers say. We prefer to let you hear their side of the story.*

Worcester, Jan. 8, 18[illegible].

To Mr. J. E. Snyder.

Dear Sir—Replying to yours of the [illegible] inst., will say, the [illegible] in., [illegible] in., [illegible] in., and [illegible] in. Upright Drills bought of you by this company are giving good satisfaction.

Respectfully yours,
H. A. YOUNG, M. M.,
With Washburn & Moen Mfg. Co.

*J. E. SNYDER, Worcester, Mass., U. S. A.*

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## The Fellows Gear Shaper

is not an experiment. Two years of test has proved that it is not only theoretically correct, but is practically the most efficient gear cutter on the market. Ask the

FELLOWS GEAR SHAPER CO.,

Springfield, Vt., about it.

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## Shapers

WE MAKE
BOTH
CRANK
AND
GEARED

Four sizes of this style, 12, 16, 20, 24 inches, with all the desirable features.

JOHN STEPTOE & CO., Cincinnati, Ohio.

[illegible]

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## WILLIAMS
## Drop-forged
## WRENCHES

*"'It don't pay nothin' to do nothin' for nobody what don't do nothin' for you.'"*

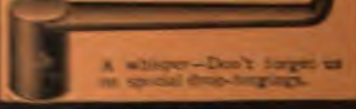
**We find it pays to be various.**

Not variable; just "various" in the way of meeting demands for all kinds of Drop-Forged Wrenches. Catalogue B (have a copy?) shows over 185 different styles and sizes, and we keep a stock of over 100,000! For the engine, the lathe, the press, the pump, the track, the bridge, etc., etc.

QUALITY ASSURED. Our Semi-Finished Wrench is case-hardened all over, with jaws milled; as good as the fully finished—grinding only excepted—and cheaper.

**CRANK HANDLES**

Supplied unfinished or with hole broached in hub. 4 sizes. QUALITY GUARANTEED. Also shown in Catalog B.



A whisper—Don't forget us on special drop-forgings.

W

**WILLIAMS' DROP-FORGINGS.**

"QUALITY PERSONIFIED."

J. H. WILLIAMS & CO.,
9-31 RICHARDS STREET,
BROOKLYN, NEW YORK.

DOMESTIC EDITION.—ADVERTISING INDEX PAGE 19.

# MACHINERY:

VOL. 6. JANUARY, 1900. No. 5.

PUBLICATION OFFICE 9~15 MURRAY STREET NEW YORK

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FOR
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**When purchasing a file, consider these points:**

*1. Quality of our Files: Best Crucible, High-Carbon Steel—Very Hard, Thorough Temper—Sharp, Strong Teeth—Every File in the Dozen and Every Dozen in the Case Uniform and Perfect.*

*2. Reputation of our Files: Supplied to 85 per cent. of Railroad Contracts in the United States—to almost 90 per cent. of largest Manufactories of the United States—to 20 Foreign Governments—to the Leading Dealers in Every Important City in the World.*

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*We issue a "FILE FILOSOPHY" telling All about Files and How to Use Them. Send for one FREE.*

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OF OUR GOODS.

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A number of the
Largest Dealers
in each
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Temper
and
Cut.**

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So. China,

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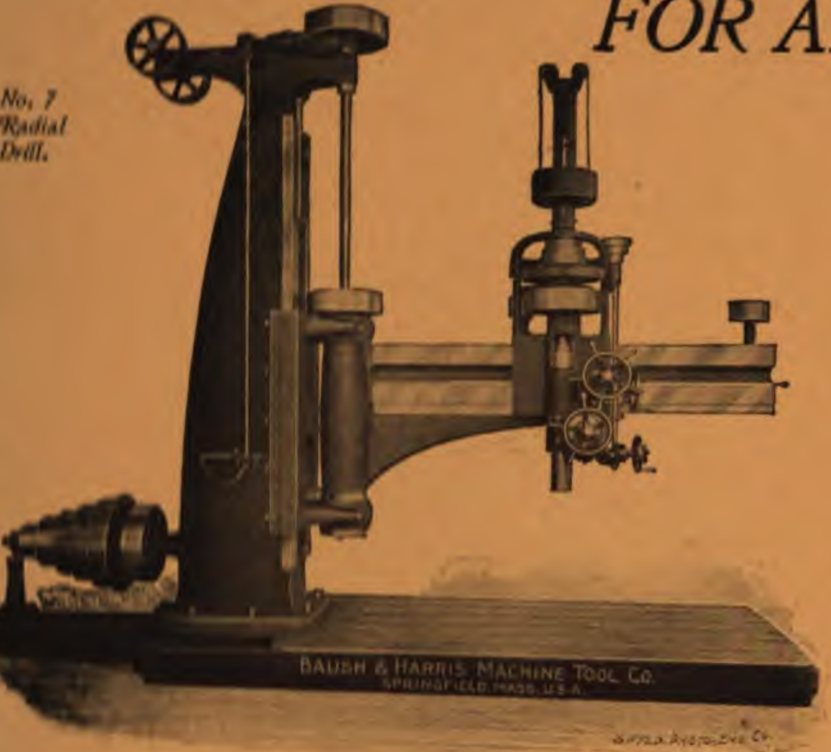

BAUSH & HARRIS MACHINE TOOL CO.
SPRINGFIELD, MASS. U.S.A.

*No. 7 Radial Drill.*

## *FOR ALL PURPOSES.*

*3 ft. to 14 ft. Swing.*

## *Multiple Drills, Boring Mills, Shapers.*

*Baush & Harris*
*Machine Tool Company,*
*SPRINGFIELD, MASS., U. S. A.*

*Sales Agents:*
MANNING, MAXWELL & MOORE, 85-87-89 Liberty St., New York. 22-24-26 So. Canal St., Chicago. Park Building, Pittsburg. 26 So. Water St., Cleveland. HILL, CLARKE & Co., Cor. Oliver & Purchase Sts., Boston.

*European Agents:*
SELIG, SONNENTHAL & Co., 85 Queen Victoria St., London, E. C. E. SONNENTHAL, JR., Berlin, Germany.

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**PUNCHES AND DIES.**

**FOR IRON AND STEEL.**

## TAPS AND DIES

OF EVERY DESCRIPTION.

**BUTTERFIELD & CO.,**

DERBY LINE, VERMONT, and ROCK ISLAND, CANADA.

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HIGH GRADE

## Vertical Drilling Machinery

We can tell you what we think of our own product, but prefer to let users of experience tell you their story. The following report is from a gentleman who has had years of practical experience in general machine shop work.

ROCHESTER, N. Y.,
Oct. [illegible]
J. E. SNYDER, Worcester, Mass.

Dear Sir:—We have now in use one [illegible]-inch drill press, one [illegible]-inch and one [illegible]-inch drill press of your make in our works and take great pleasure in stating that we consider them the best drill presses we have ever used or seen. We can do more work and do it easier and better than on any other machine of same kind we have ever used. They cost nothing for repairs, although in constant use, often twelve hours per day the year round, and should we require more drill presses we should certainly buy the Snyder drill. You are at liberty to refer to us at any time.

Yours truly,
THE J. S. GRAHAM MACHINE CO.,
[illegible], Vice-Pres.

*J. E. Snyder, Worcester, Mass. U. S. A.*

---

## IT'S THE CUTTER THAT DOES IT.

You might have a perfect machine, but your gears would be "out" as much as your cutter, and unless your cutter is ground after it is hardened, it is certainly "out."

We grind the tooth form of our cutter after it is hardened.

The Fellows Gear Shaper Co.
Springfield, Vermont.

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**HIGH GRADE** **SHAPERS**

This is our Triple Geared Shaper, made in four sizes, 20, 24, 28 and 32 inches. Embodying the latest mechanical improvements in these tools.

JOHN STEPTOE & CO., Cincinnati, Ohio.

[illegible]

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## THIS DOG NEVER BARKS NOR WAGS ITS TAIL.

Its tail is always bent.
This Dog is Drop-Forged.

**Lathe Dogs 3-8 in. to 4 in.**
Strong, yet light. The cross section is ogee-shaped; the rib on the back insures strength. Screws made of steel, points hardened; from 1-16 in. to 1-8 in. larger than those generally used.

**ASK FOR CATALOG B,**
which also shows over 185 different sizes and styles of Wrenches (drop-forged), of which over 100,000 are kept in stock. Also machine Handles, Shafting, Collars, Keys, Eye Bolts, Crank Handles, Thumb Nuts, Thumb Screws, etc.

**J. H. WILLIAMS & CO.,**
9-31 Richards St., Brooklyn, N. Y.

TRADE MARK W

**WILLIAMS'**
**DROP-FORGINGS.**
"QUALITY PERSONIFIED."

J. H. WILLIAMS & CO.,
9-31 RICHARDS STREET,
BROOKLYN, NEW YORK.

DOMESTIC EDITION.—ADVERTISING INDEX PAGE 19.

Cairns

# MACHINERY:

Vol. 6. FEBRUARY, 1900. No. 6.

PUBLICATION OFFICE 9-15 MURRAY STREET NEW YORK

A PRACTICAL JOURNAL FOR THE MACHINE SHOP

ONE DOLLAR A YEAR ~ TEN CENTS A COPY.

**BROWN & SHARPE MFG. CO.,**

**. . . . Providence, R. I., U. S. A.**

**Gear Cutters**

**. . . and . . .**

**Milling Cutters**

**of Every Kind.**

**36 Varieties,**

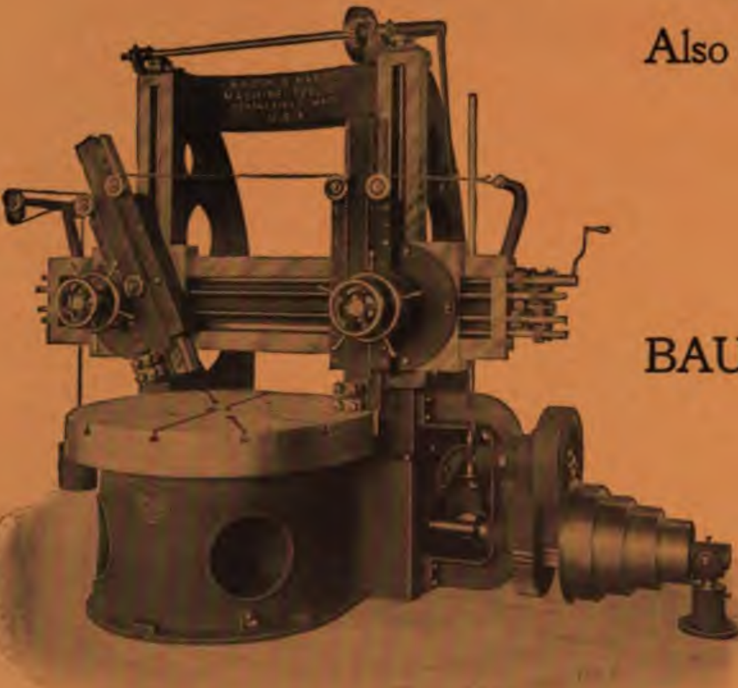
**3,500 Sizes.**

**Cutter List mailed to any address on application.**

**NEW YORK OFFICE: 136 Liberty St.** **CHICAGO OFFICE AND STORE: 23 South Canal St.**

# BORING MILLS . . .

37 in., 51 in., 61 in.



## Also Radial Drills and Multiple Drills

for every purpose.

**BAUSH & HARRIS
MACHINE TOOL CO.,**

Springfield, Mass., U.S.A.

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**AMERICAN AGENTS.**

Manning, Maxwell & Moore, New York, 85-87-89 Liberty St.; Chicago, 22-24-26 So. Canal St.; Pittsburg, Park Building; Cleveland, 26 So. Water St.
Hill, Clarke & Co., Boston, cor. Oliver and Purchase Sts.

**EUROPEAN AGENTS.**

Selig, Sonnenthal & Co., London, E. C., 85 Queen Victoria St.
E. Sonnenthal, Jr., Berlin, Germany,

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**PUNCHES AND DIES.**

**FOR IRON AND STEEL.**

## TAPS AND DIES

OF EVERY DESCRIPTION.

**BUTTERFIELD & CO.,**

**DERBY LINE, VERMONT, and ROCK ISLAND, CANADA.**

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WYMAN & GORDON
WORCESTER, MASS.
DROP FORGINGS
— WOOD WORKERS' VISES —

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## Wire Mills,
## Wire Nail Mills,
## Chain Factories.

**Complete or in part.
Designed and Built.
Write for Catalogue.**

## The Turner, Vaughn and Taylor Co.,

**CUYAHOGA FALLS, OHIO, U.S.A.**

Cable Address, Vaughn, Cuyafalls. A. B. C. and Atlantic Cable Directory Codes used.

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## The Fellows Gear Shaper

is not an experiment. Two years of test has proved that it is not only theoretically correct, but is practically the most efficient gear cutter on the market. Ask the

FELLOWS GEAR SHAPER CO.,

Springfield, Vt., about it.

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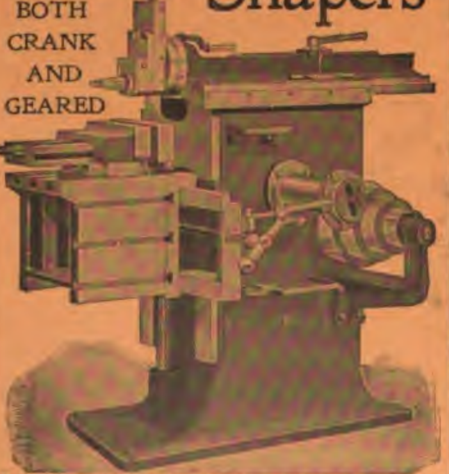
WE MAKE
BOTH
CRANK
AND
GEARED

## Shapers



Four sizes of this style, 12, 16, 20, 25 inches, with all the desirable features.

JOHN STEPTOE & CO., Cincinnati, Ohio.

Sole European Agents: Selig, Sonnenthal & Co.,
85 Queen Victoria St., London, E. C.
Sole Agent in Germany: E. Sonnenthal, Jr., 5, Neue Promenade Berlin.

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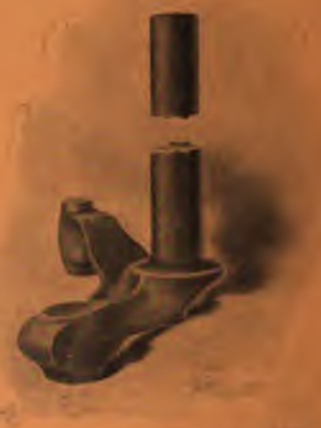
**A WILLIAMS DROP-FORGING.**



*We're Forging Ahead Always,
And Our Forgings Are Always
Ahead.* *WILLIAMS.*

Does above cut suggest any way in which we can assist you?

We surely *can* assist you if you are building special machinery of any kind, tools, lathes, presses, pumps, hoisting apparatus, motors, etc., etc., for you probably use *some* Drop-Forgings in their construction and our knowledge of quality and other requisites may be valuable to you.

Perhaps we can suggest economies to you. Some way of lightening the parts, yet retaining strength. A slight change here and there often makes a surprising difference.

Our experience is at your command. We will gladly submit specimens of work. May we be remembered by you?

**OUR CATALOGUE B**

shows drop-forged Wrenches of standard design—over 185 sizes and styles—over 150,000 in stock.

Hoping to hear from you, we are
Yours Drop-Forgingly,

**J. H. WILLIAMS & CO.**

**9-31 RICHARDS ST. BROOKLYN, N. Y.**

DOMESTIC EDITION.—ADVERTISING INDEX PAGE 36. Leainne

# MACHINERY:

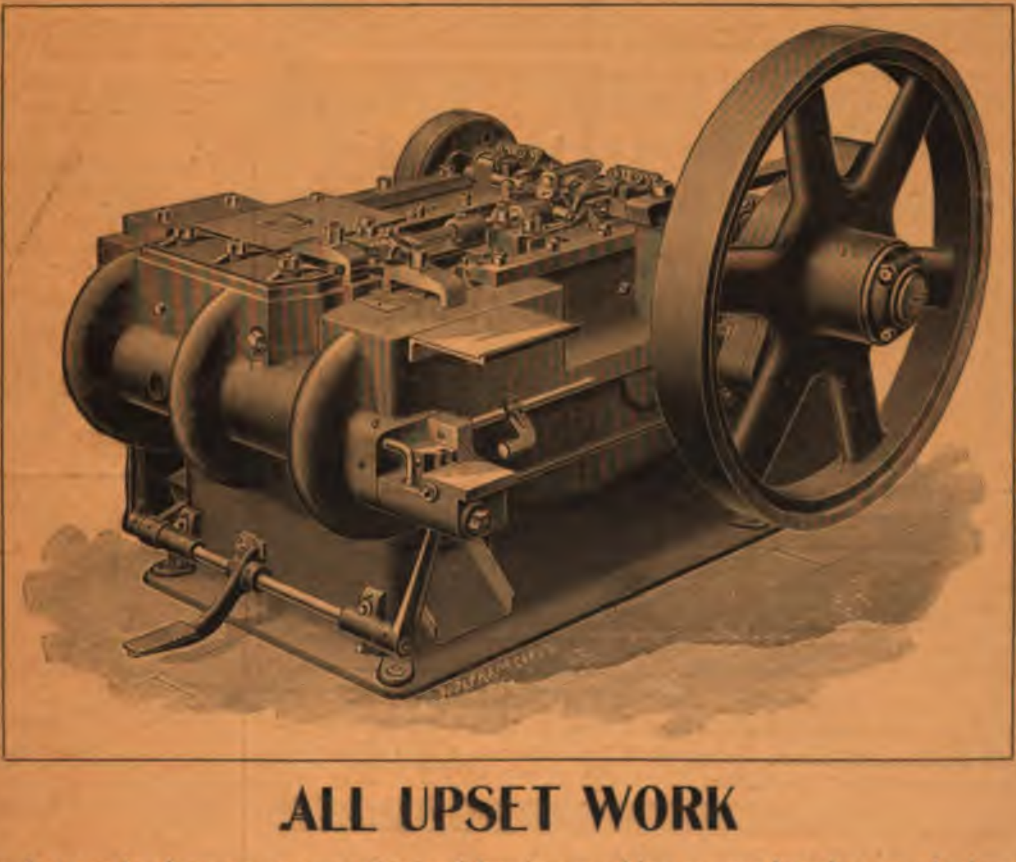
VOL. 6. MARCH, 1900. No. 7.

PUBLICATION OFFICE 9-15 MURRAY STREET NEW YORK

A PRACTICAL JOURNAL FOR THE MACHINE SHOP

ONE DOLLAR A YEAR - TEN CENTS A COPY.

The Acme
Heading and Forging Machine.



ALL UPSET WORK

or Forgings that can be done on an upsetting and forging machine are produced so much cheaper than by any other process that all live manufacturers should investigate the Acme Heading and Forging Machine.

We shall be pleased to give an estimate of production of our machines if furnished with blue-prints or sketches of pieces. Please ask for catalogue.

We also build the Acme Bolt-cutters, Nut-tappers, etc.

THE ACME MACHINERY COMPANY, Cleveland, Ohio.

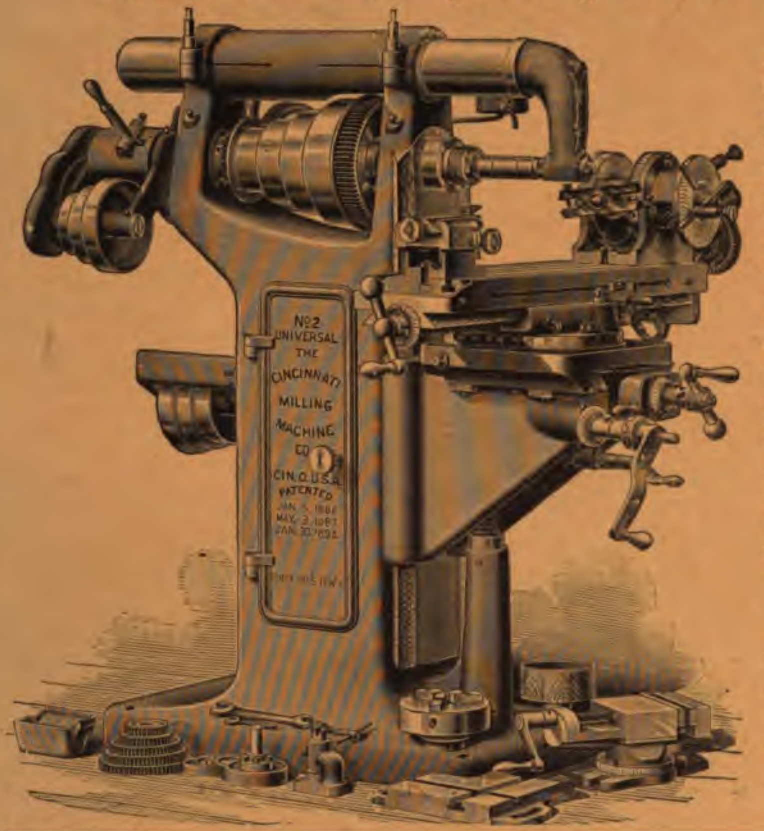
FOREIGN AGENTS: Messrs. C. W. Burton, Griffiths & Co., London. Mr. Adolphe Janssens, Paris. Messrs. Schuchardt & Schutte, Berlin, Vienna, Brussels, Stockholm, Cologne, St. Petersburg.

# Marshall & Huschart Machinery Company,

**62 and 64 South Canal Street, Chicago.**

**CLEVELAND OFFICE, 19 So. Water St.** **CINCINNATI OFFICE, 510 Johnston Bldg.**

## Dealers in the highest grade of American Machine Tools.



WE REPRESENT

- Bickford Drill & Tool Co., Radial Drills.
- Gould & Eberhardt, Gear Cutters and Shapers.
- Cincinnati Milling Machine Co., Milling Machines.
- Ferracute Machine Co., Power Presses.
- L. W. Pond Machine Co., Iron Planers.
- J. E. Snyder, Upright Drills.
- Lodge & Shipley Machine Tool Co., Engine Lathes.
- Dreses, Mueller & Co., Screw Machines and Turret Lathes.
- Cincinnati Planer Co., Iron Planers.
- Graves & Kluseman, Engine Lathes.
- Barker & Chard, Engine Lathes.
- Aurora Tool Works, Upright Drills.
- National Machinery Co., Bolt and Nut Machinery.
- Perry Ransom, Vulcan Grinding Machinery.
- The Scranton Co., Upright Power Hammers.
- Cincinnati Machine Tool Co., Upright Drills.
- Spencer Automatic Machine Screw Co., Automatic Screw Machines.
- Whitney Manufacturing Co., Hand Millers and Water Grinders.
- Fitchburg Machine Co., Lathes and Planers.
- Bullard Machine Tool Co., Boring Mills and Turret Lathes.
- Landis Tool Co., Universal Grinders.

**Send for our latest list. We carry a fine assortment in stock.**

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U. S. S. "OREGON" FORGING AHEAD.

# FORGING AHEAD!

WILLIAMS.

**Ask for Catalogue B.**

**We are Forging Ahead always,**
**And our Forgings are always ahead.** WILLIAMS.

*9 to 31 Richards Street, Brooklyn, New York, March 1, 1900.*

*We invite a visit to our exhibit at the Paris Exposition, 1900, in Gallery section, U. S. A., Palace of Mines, Champs de Mars, where an officer of our company will give desired information.* *J. H. WILLIAMS & CO.*

## "Forgings Ahead."

If you need special Drop-Forgings of guaranteed quality, close to size, we can serve you. You need not pay for "wasters." If you order 2,000 forgings you get 2,000 GOOD forgings. This is an economical advantage. We drop-forge Bronze, Copper, Aluminum, Iron and Steel. Parts of fine machinery, motors, tools, engines, pumps, automobiles, etc., made to order.

### Williams Drop-Forged Spanner Wrenches.

Nearly 200 different sizes and styles. Over 160,000 in stock! Quality guaranteed. Our Engineers' Wrenches are made with openings at 15 degree angle with handle, to permit of working in narrow quarters. Ask for Catalogue B.

### Vulcan Chain Pipe Wrench.

16 sizes; 8 each with cable and flat link chain. For fittings on pipe 1-8 in. to 18 in. diameter. Ask for Catalogue B.

**Prompt Deliveries.** Orders for regular sizes of standard goods usually filled on the day received.

J. H. WILLIAMS & CO.

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# IT'S THE CUTTER THAT DOES IT.

You might have a perfect machine, but your gears would be "out" as much as your cutter, and unless your cutter is ground after it is hardened, it is certainly "out."

We grind the tooth form of our cutter after it is hardened.

The Fellows Gear Shaper Co.

Springfield, Vermont.

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# HIGH GRADE SHAPERS

This is our Triple Geared Shaper, made in four sizes. 20, 24, 28 and 32 inches. Embodying the latest mechanical improvements in these tools.

JOHN STEPTOE & CO., Cincinnati, Ohio.

Sole European Agents: Selig, Sonnenthal & Co.,
85 Queen Victoria St., London, E. C.
Sole Agent in Germany: E. Sonnenthal, Jr., 5 Neue Promenade, Berlin.

DOMESTIC EDITION.—ADVERTISING INDEX PAGE 19. Cairn

# MACHINERY:

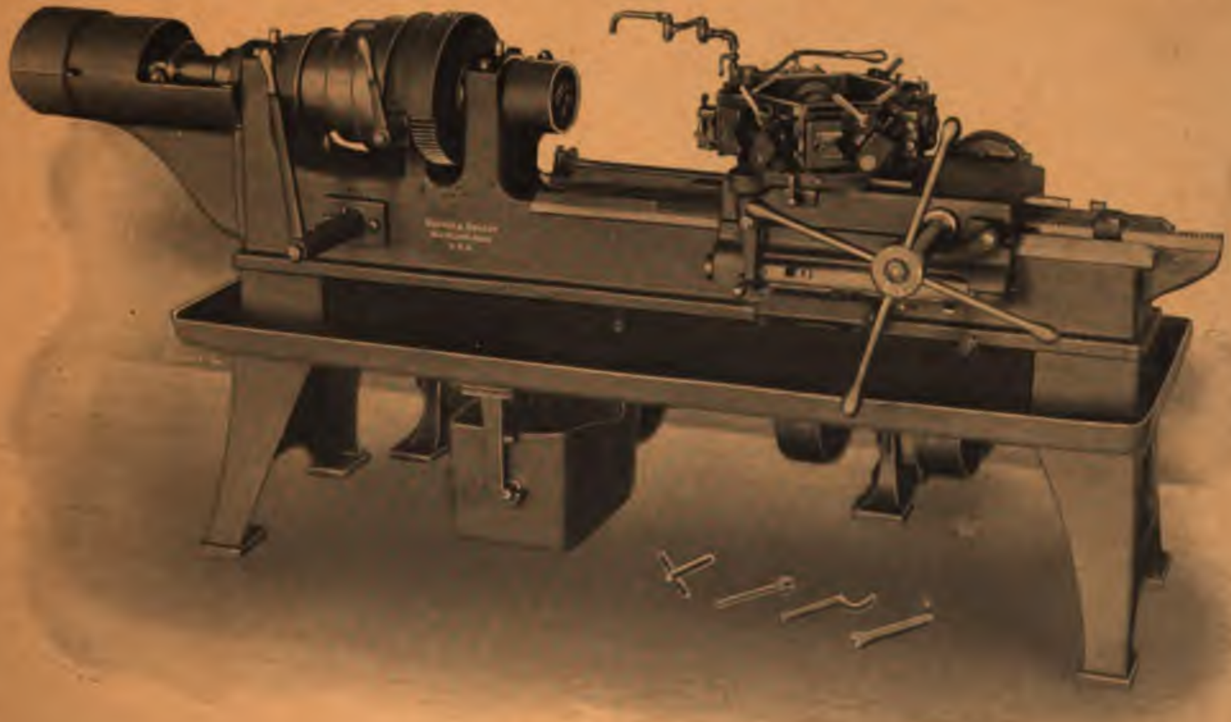
VOL. 6. APRIL, 1900. No. 8.

PUBLICATION OFFICE 9-15 MURRAY STREET NEW YORK

A PRACTICAL JOURNAL FOR THE MACHINE SHOP

ONE DOLLAR A YEAR - TEN CENTS A COPY.

The Hollow Hexagon Turret Lathe.



PRINCIPAL FEATURES

Range of work, 2 inches in diameter, 24 inches long. Automatic Chuck and Roller Feed: Head cast solid with Bed; Large Hexagon Turret with Independent Stop for each tool; complete set of tools furnished with the machine.

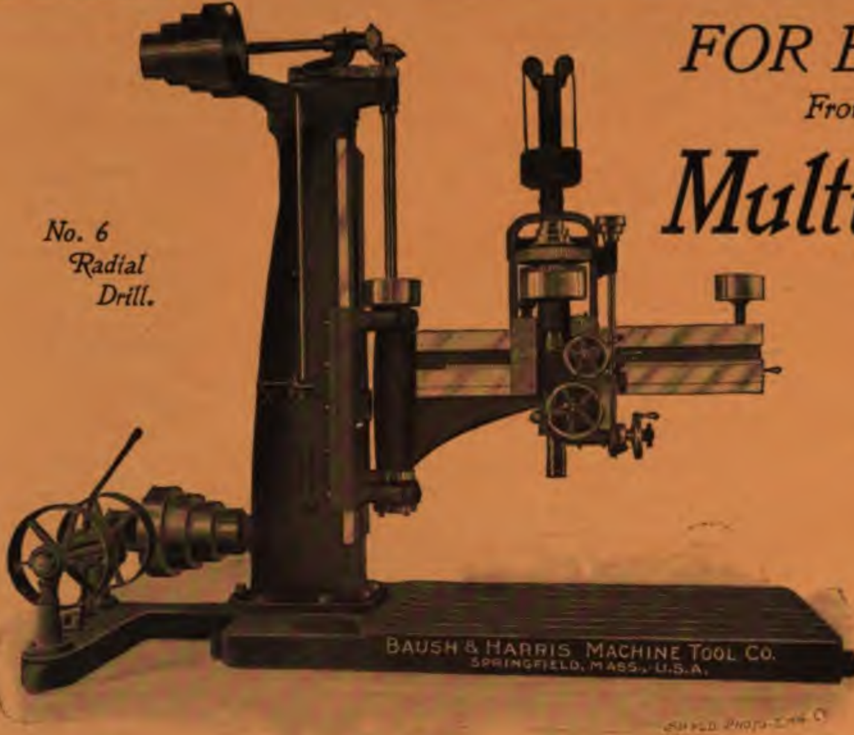
SEND FOR CATALOGUE.

WARNER & SWASEY, Cleveland, Ohio, U. S. A.

EUROPEAN AGENTS: Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow. Schuchardt & Schutte, Berlin, Vienna, Brussels and Stockholm. Mr. Adolphe Janssens, Paris.

# Radial Drills...

*No. 6 Radial Drill.*


BAUSH & HARRIS MACHINE TOOL CO.
SPRINGFIELD, MASS., U.S.A.

## *FOR EVERY PURPOSE*

*From 2 1-2 ft. to 12 ft. Arm.*

## *Multiple Drills*

*From 4 to 24 Spindles.*

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*CATALOG DESCRIBES THEM.*

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## *Baush & Harris Machine Tool Co.*

*Springfield, Mass., U. S. A.*

*American Agents:*

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HILL, CLARKE & Co., Boston, cor. Oliver & Purchase Sts.

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SELIG, SONNENTHAL & Co., London, E. C., 85 Queen Victoria St.

E. SONNENTHAL, JR., Berlin, Germany.

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**QUALITY.**

# WILLIAMS DROP-FORGINGS.

**REPUTATION**
**for**
**QUALITY.**

There never was a time when King Quality held as despotic a sway in mechanical fields as he does to-day. A product that once gets a reputation for high quality has a sure market foothold. Years ago we realized this, and we have built up our Drop-Forging business upon Quality. We knew that the guaranteed forging would stay, once it got here. And it has. The Williams Drop-Forgings are noted for their quality, which we guarantee, and their users never put worthless parts into their machines. Every forging that leaves our place is carefully inspected and approved. You pay for no "wasters." Then, there's the economy of it. Economy in machining, we mean. Often only a file finish is necessary. A grinding finish is usual. Consult with us.

**J. H. WILLIAMS & CO.**
**9-31 Richards Street, Brooklyn, New York.**

**CLOSE-TO-SIZE-NESS.**

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# IT'S THE CUTTER THAT DOES IT.

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85 Queen Victoria St., London, E. C.
Sole Agent in Germany E. Sonnenthal, Jr., 3 Neue Promenade, Berlin.

DOMESTIC EDITION.—ADVERTISING INDEX PAGE 53.

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# MACHINERY:

Vol. 6. JUNE, 1900. No. 10.

PUBLICATION OFFICE 9–15 MURRAY STREET NEW YORK

## A PRACTICAL JOURNAL FOR THE MACHINE SHOP

ONE DOLLAR A YEAR – TEN CENTS A COPY.

**Specialists in Drilling Machinery**

Our drills are the result of twenty-five years' experience, and represent a line of Tools as nearly perfect as we can make them.

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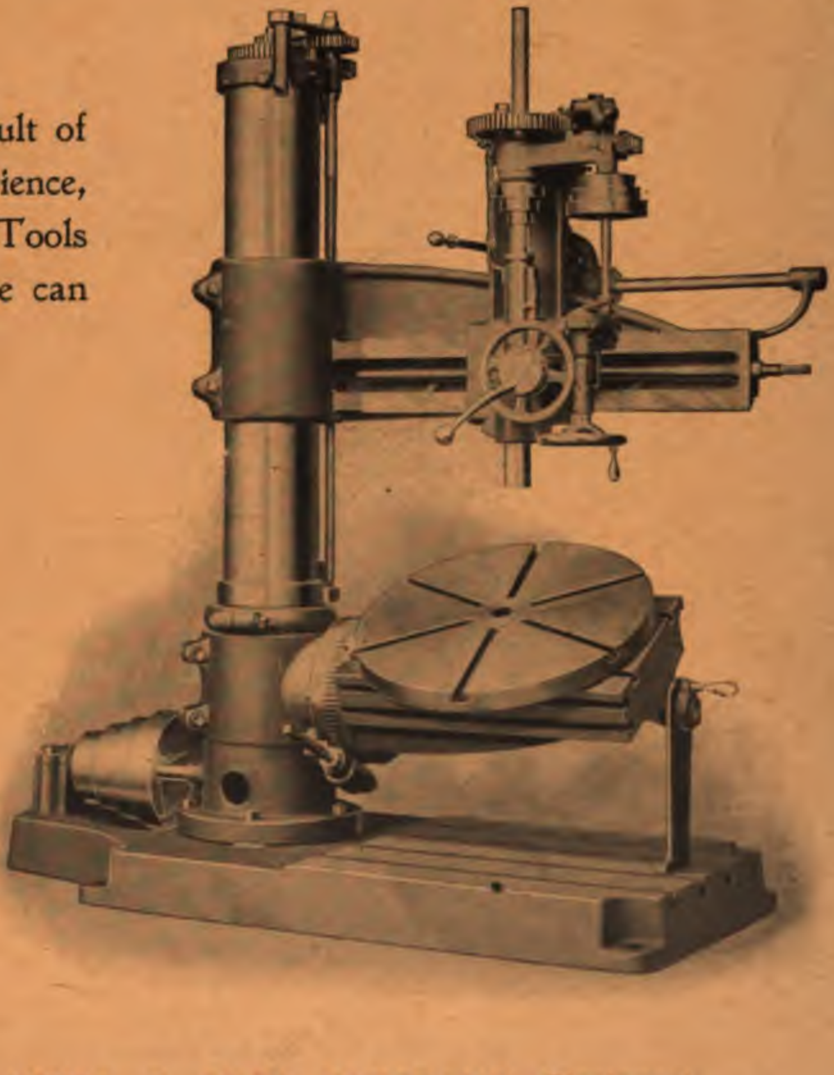


**Paris Exposition,**

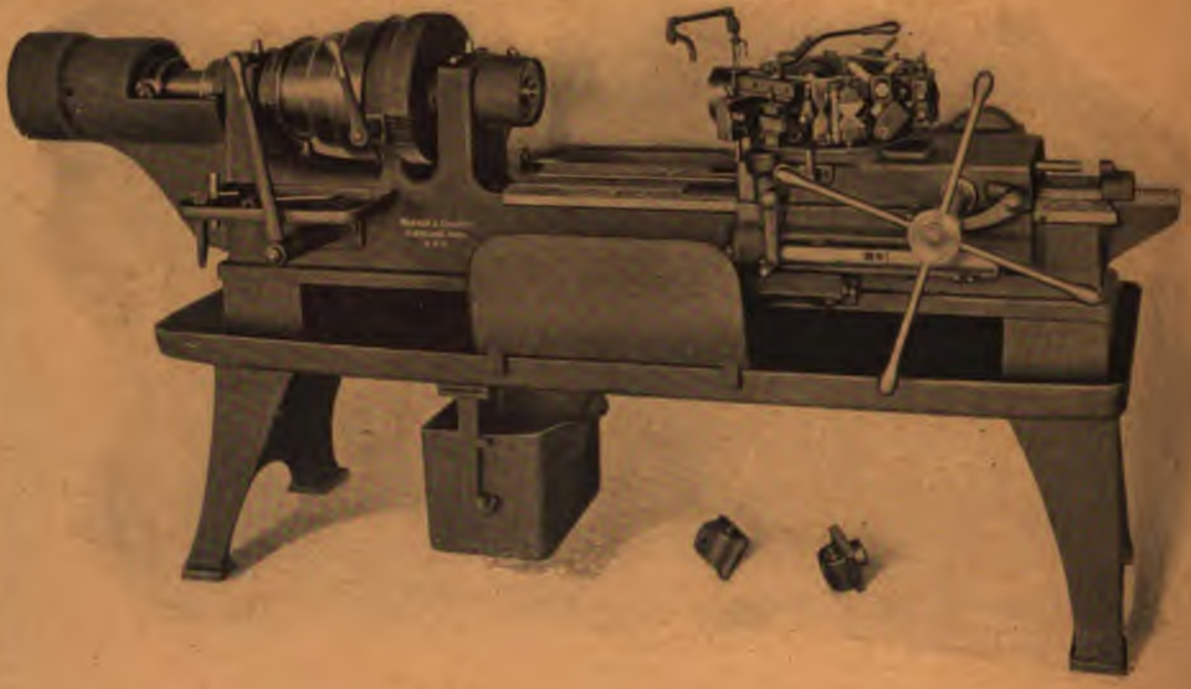
Vincennes Annex,
Space 13,
Champ de Mars Building,
Space 9.

**See our Exhibit.**

**THE BICKFORD DRILL & TOOL COMPANY,** Cincinnati, Ohio, U. S. A.

**AGENTS: New York and Buffalo,** Prentiss Tool & Supply Co. **Chicago and Cleveland,** Marshall & Huschart Machinery Co. **Pittsburgh Pa.,** Brown & Zortman Machinery Co. **St. Louis, Mo.,** J. W. Wright & Co. **Philadelphia, Pa.,** W. B. Shipley. **Cincinnati, Ohio.,** The E. A. Kinsey Co. **Baltimore, Md.,** Morton, Reed & Co. **San Francisco, Cal.,** Henshaw, Bulkley & Co. **Portland, Oregon,** Cawston & Co.

# The Hollow Hexagon Turret Lathe.



## PRINCIPAL FEATURES.

Range of work, 2 inches in diameter, 24 inches long. Automatic Chuck and Roller Feed; Head cast solid with Bed; Large Hexagon Turret with Independent Stop for each tool; complete set of tools furnished with the machine.

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**SEND FOR NEW CATALOGUE.**

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**WARNER & SWASEY, CLEVELAND, OHIO, U. S. A.**

EUROPEAN AGENTS: Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow. Schuchardt & Schutte, Berlin, Vienna, Brussels, Stockholm and Cologne. Adolphe Janssens, Paris.

DOMESTIC EDITION.—ADVERTISING INDEX PAGE 22.

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# MACHINERY:

VOL. 6. JULY, 1900. No. 11.

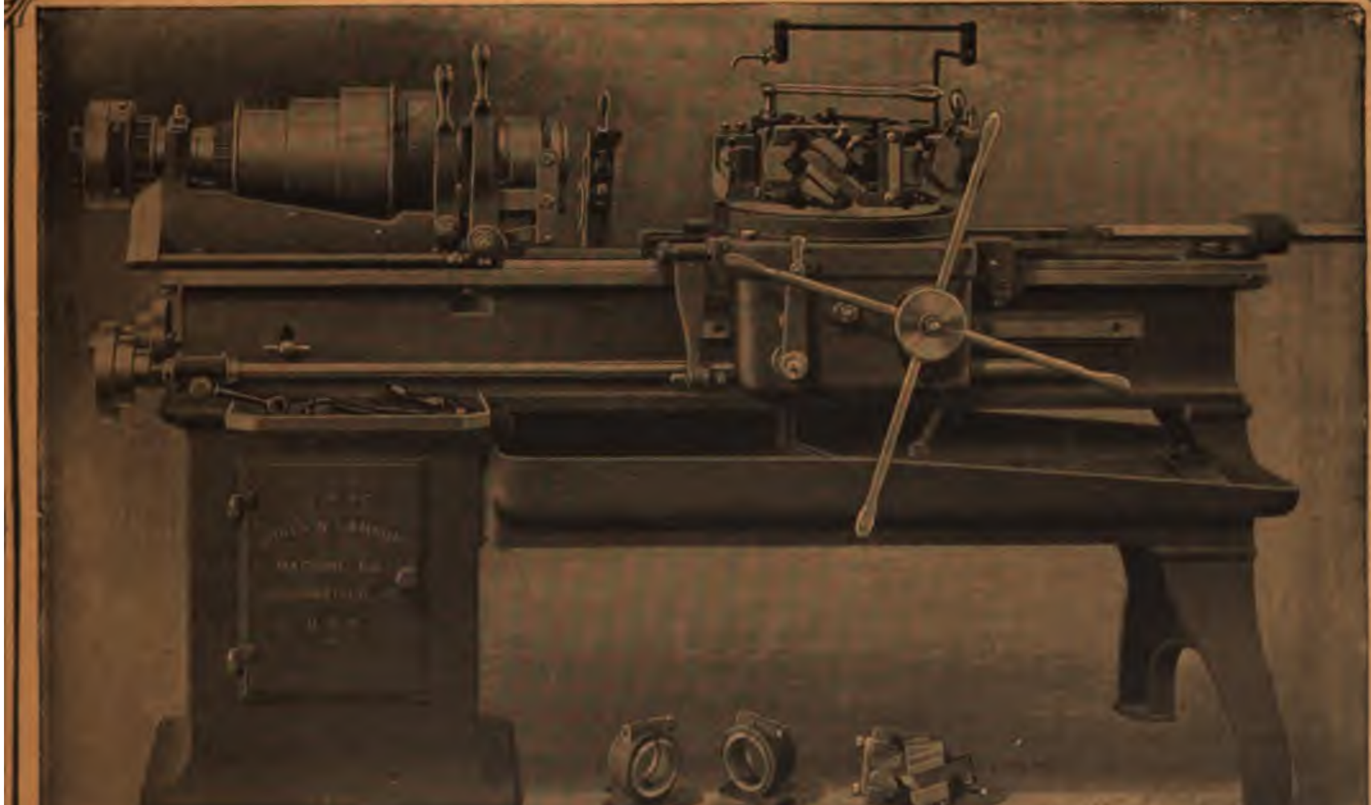
PUBLICATION OFFICE 9-15 MURRAY STREET NEW YORK

A PRACTICAL JOURNAL FOR THE MACHINE SHOP.

ONE DOLLAR A YEAR - TEN CENTS A COPY.

## Distinctive Claims of the Flat Turret Lathe.

The Tools do not overhang. The entire design is compact. The locking pin is directly under the working tool The Turret is gibbed at its outer edge. The Turret Slide does not overhang. The chuck grips round, square and hexagon stock. The tools do not mark the work in running back. Tools are quickly set to any size. Turret turns to the places desired only. Each tool travels the length of its own cut only. Each turning Tool and and Back Rest readily adjusted to any size. Only three levers to operate the cutting tools. Only one shipper to operate the three-friction countershaft. Oil follows the cut without attention. Turning Tools are simplest form.



Made in one size only. Capacity 2 in. in diameter when working from full length bars, and almost any diameter up to 16 in. when working from forgings. Any piece of work from a washer ⅛ in. thick to a shaft 24 in. or 36 in. long.

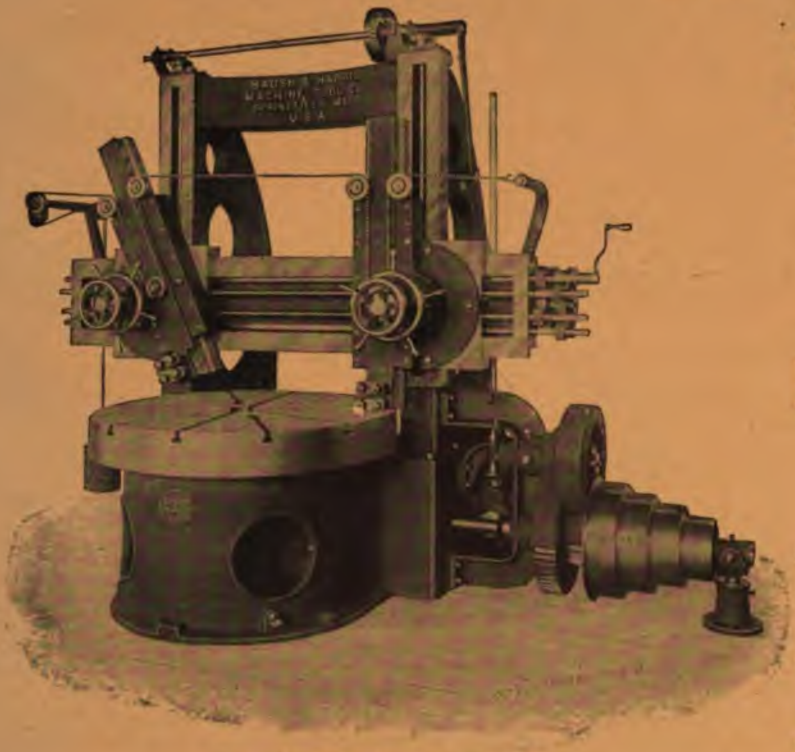
The outfit of tools furnished with the machine turns and threads all diameters from 2 in. down, and all lengths under 24 in.

**JONES & LAMSON MACHINE COMPANY, Springfield, Vermont, U. S. A.**

ENGLISH OFFICES: JONES & LAMSON MACHINE CO., 6 Exchange Bldg., Stephenson's Place, Birmingham. HENRY KELLEY & CO., 23 Pall Mall, Manchester. GERMANY, HOLLAND, BELGIUM, SWITZERLAND and AUSTRIA-HUNGARY: M. KOYEMANN, Charlottenstrasse, 112, Düsseldorf, Germany. FRANCE: Ph. Bonvillian, 6, Rue Blanche, 6, Paris. ITALY: Adler & Eisenschitz, Milan.

# BORING MILLS,

30 in. 37 in. 51 in. 61 in.



51 in. BORING AND TURNING MILL.

## Radial Drills,

## Multiple Drills.

⁂

## Baush Machine Tool Company,

Springfield, Mass., U. S. A.

Successors to Baush & Harris Machine Tool Company,

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*American Agents:*

Manning, Maxwell & Moore, New York, 85-87 89 Liberty Street.
Chicago, 22-24-26 South Canal Street. Pittsburg, Park Building.
Cleveland, 26 South Water Street.

*European Agents:*

Selig, Sonnenthal & Co , London, 85 Queen Victoria Street.
E. Sonnenthal, Jr., Berlin, Germany.

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## Do you know of any

make-shift-metal machine or tool parts or tools entire that should be replaced with well designed and serviceable drop-forgings and these forgings offered from stock? We have just created 5 new lines (see 1900 Catalogue "B" just ready,)

**Rod Ends, Crank Shafts, Poppet Valve Stems, Straight Tail Dogs, Socket Wrenches.**

and are ready for further undertakings

**J. H. WILLIAMS & CO., Brooklyn, New York.**

## The Fellows Gear Shaper

is not an experiment. Two years of test has proved that it is not only theoretically correct, but is practically the most efficient gear cutter on the market. Ask the

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Sole Agent in Germany E. Sonnenthal, Jr., 5. Neue Promenade Berlin.

DOMESTIC EDITION.—ADVERTISING INDEX PAGE 19.

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# MACHINERY:

VOL. 6. AUGUST, 1900. No. 12.

PUBLICATION OFFICE 9-15 MURRAY STREET NEW YORK

A PRACTICAL JOURNAL FOR THE MACHINE SHOP.

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BROWN & SHARPE MFG. CO.,
Providence, R. I., U. S. A.

Plain Grinding Machines
. . . FOR . . .
Manufacturing Economically.

Simple. Powerful. Rigid. Automatic. Accurate.

Automatic Cross Feed. No Water Guards required. All working parts protected from water and grit. Rapidity of manipulation an important feature. Will grind all work, either straight or taper, revolving upon two dead centres.

*Catalogue and Descriptive Circulars mailed to any address upon application.*

New York Office: 136 Liberty St. Chicago Office and Store: 23 South Canal St.

# MULTIPLE DRILLS

BAUSH MACHINE TOOL CO.
SPRINGFIELD, MASS. U. S. A.

Latest Improved.....
.....Best Design.

4 to 24 Spindles. 12 to 36 circle.

* * *

## Radial Drills

.....and.....

## Boring Mills.

* * *

## Baush Machine Tool Company,

**Springfield, Mass.**

Successors to Baush & Harris Machine Tool Company.

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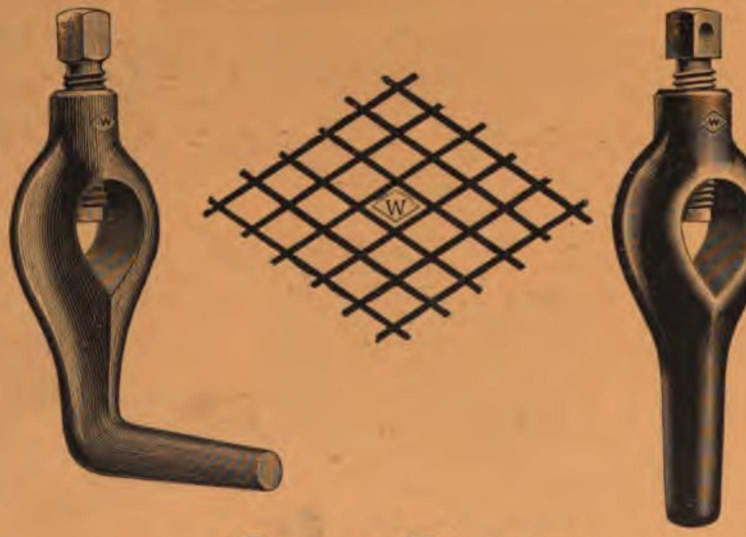

# Our Dog

product is not of the "barking" variety but their superior strength and unfailing screw-bite has necessitated our adding storing-kennels for the Straight Tail variety. We are making, too, a 5 inch size of both Bent and Straight Tail kinds—very large drop-forged Dogs, superior in every respect and moderate in price.

**Drop-forging** || **What will you choose ?** || **or Casting.**

No manufacturer or machine-shop should be without 1900 Catalogue "B".

**J. H. WILLIAMS & CO., Brooklyn, N. Y.**

## IT'S THE CUTTER THAT DOES IT.

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## Shapers

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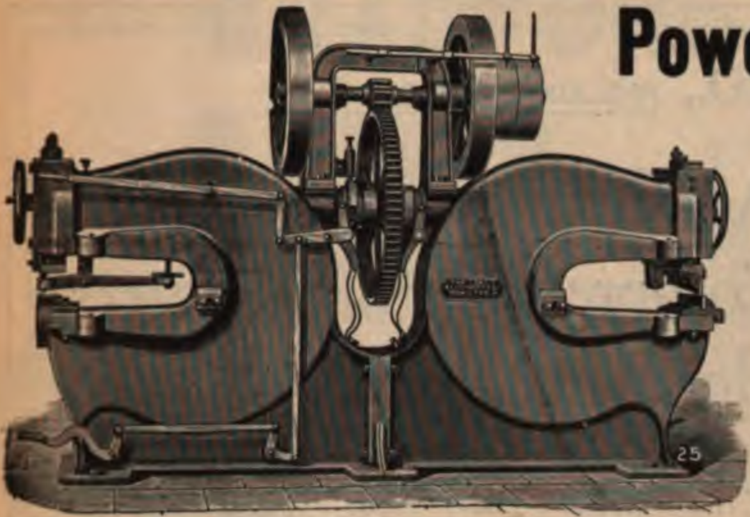

# Power Punching and Shearing Machinery.

**Belt, Steam and Electrically Driven.**

Single, Double, Upright, Horizontal, Gate, Multiple.

**Over 350 Sizes and Varieties for use in**

Railroad Shops, Locomotive Shops, Bridge Works, etc., etc.

**THE LONG & ALLSTATTER CO.**

**HAMILTON, OHIO, U. S. A.**

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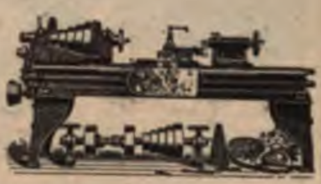

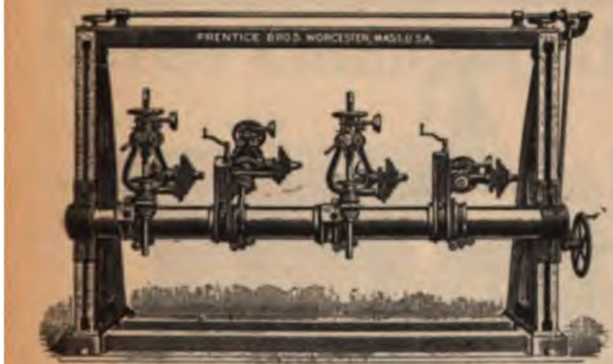
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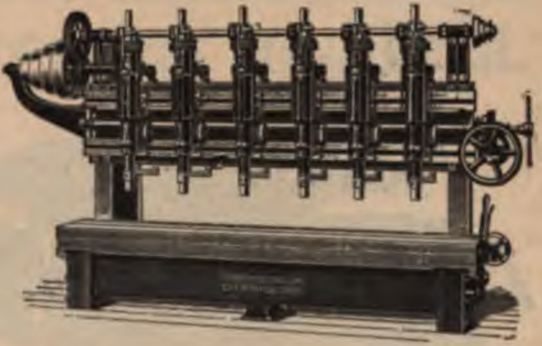

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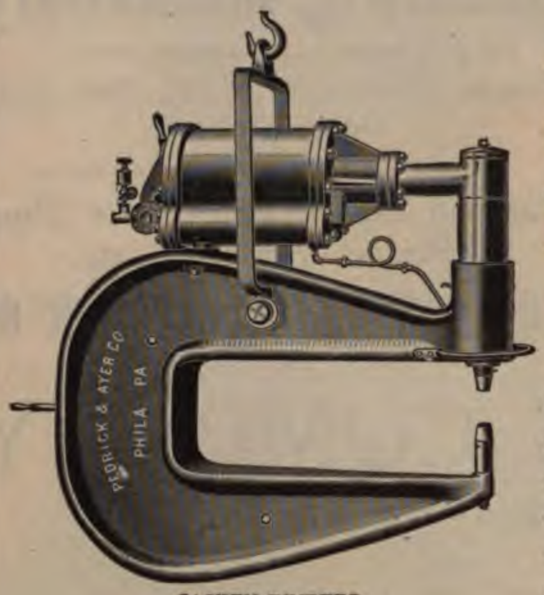

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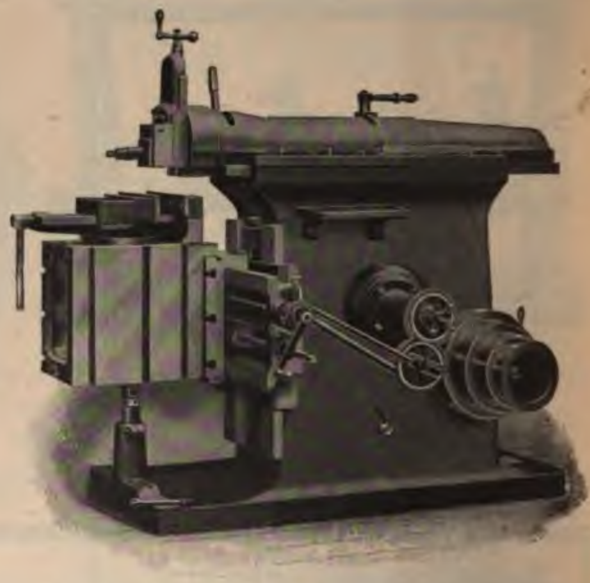

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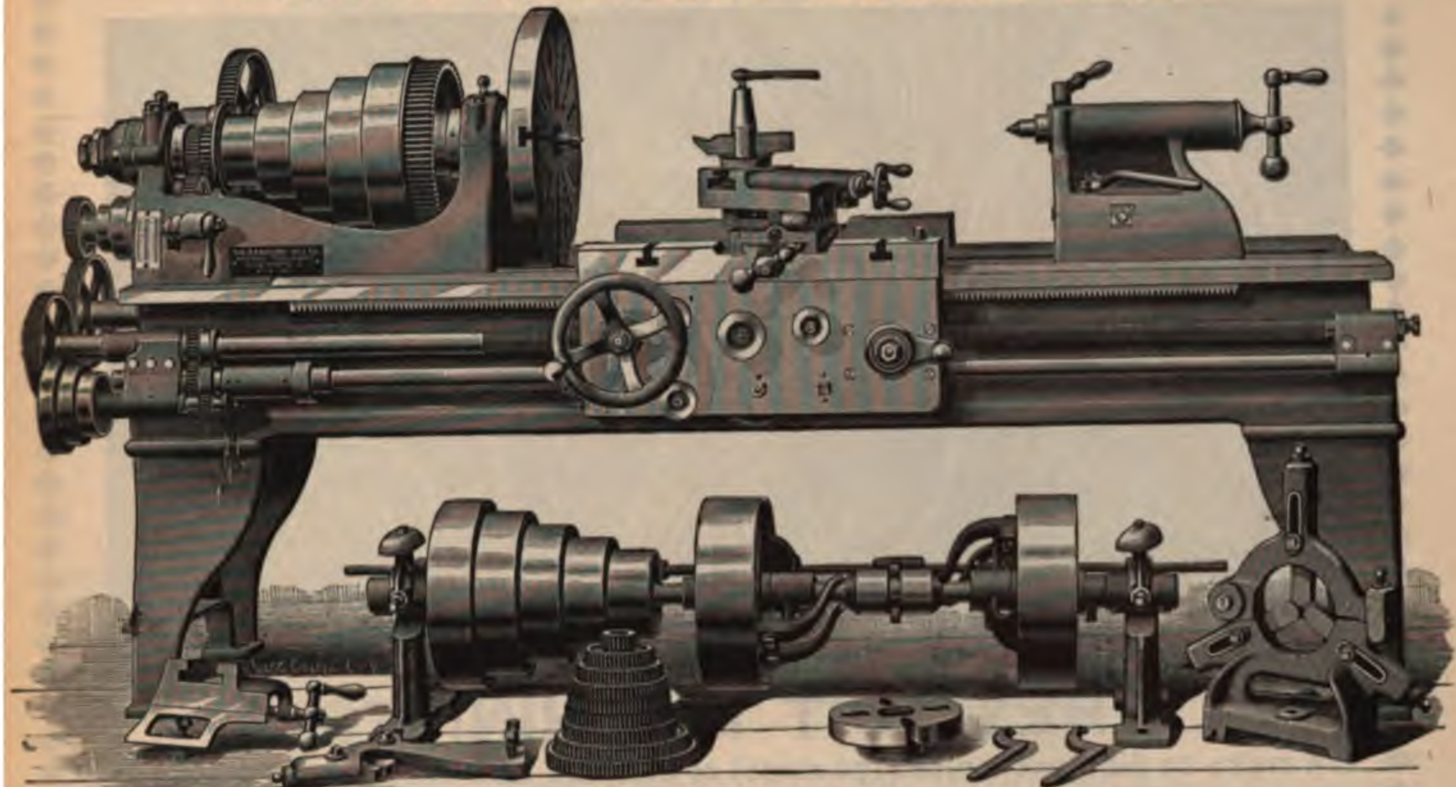

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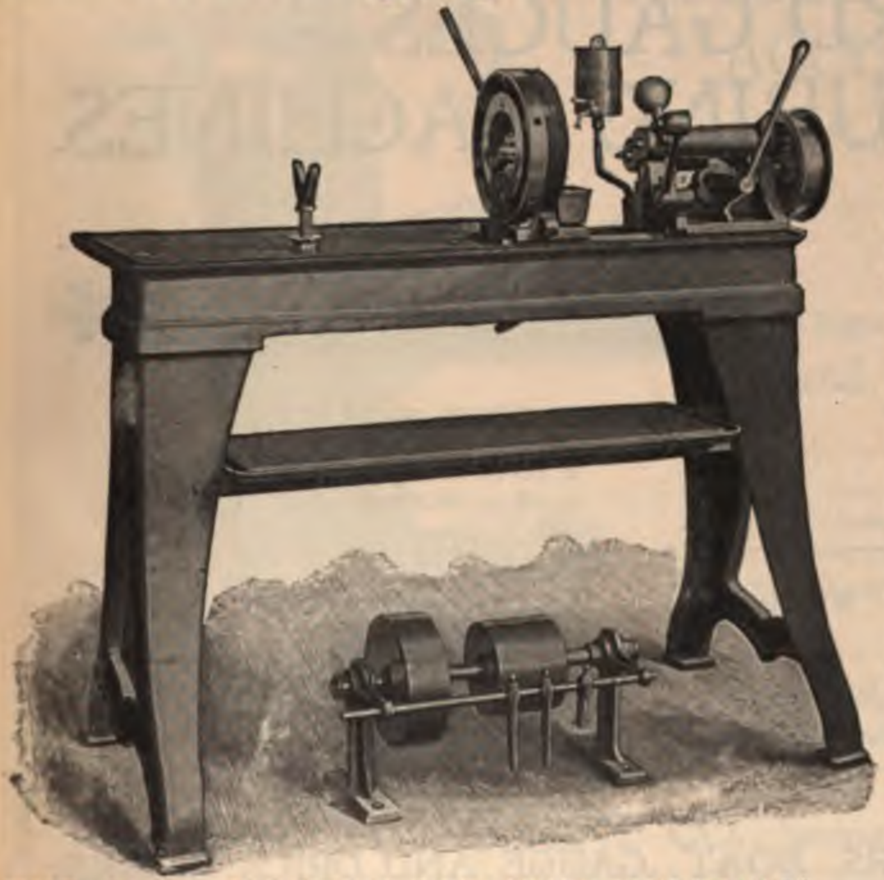

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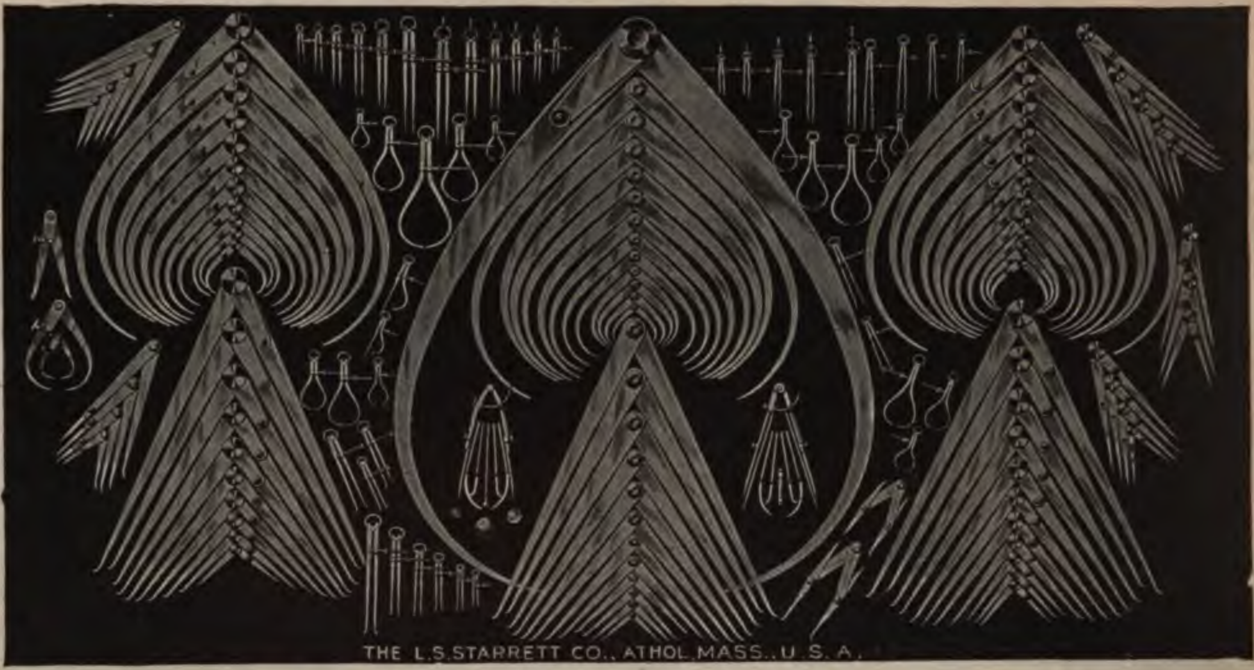

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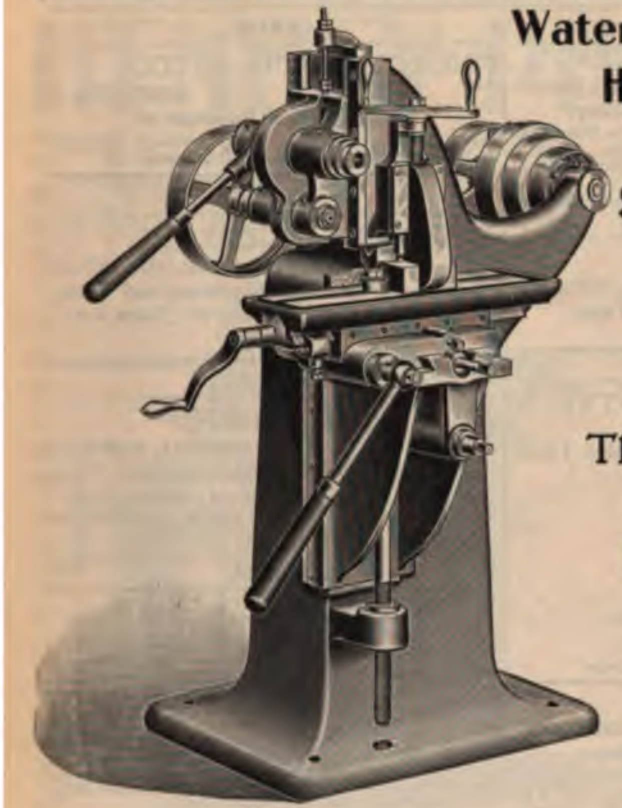

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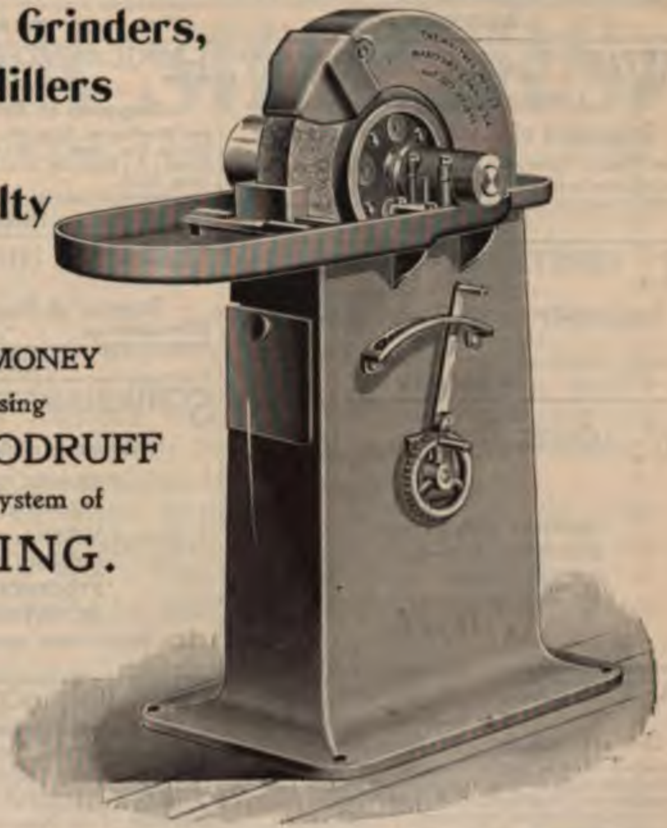

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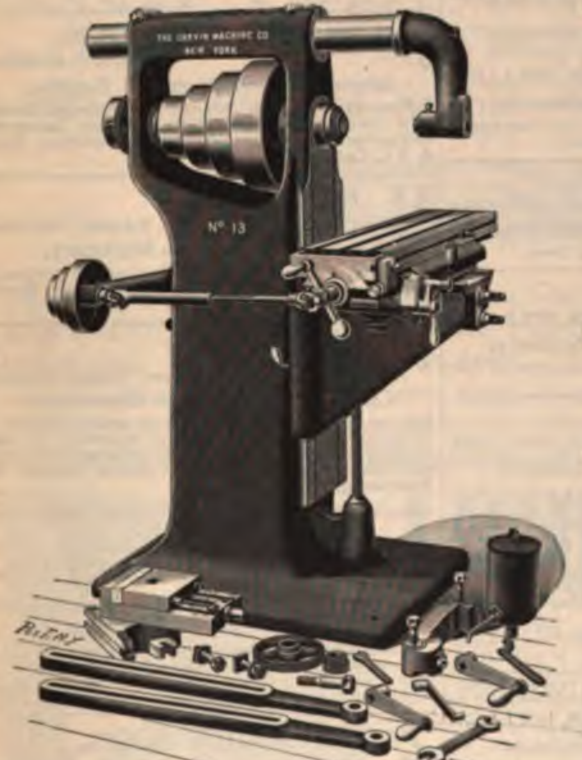

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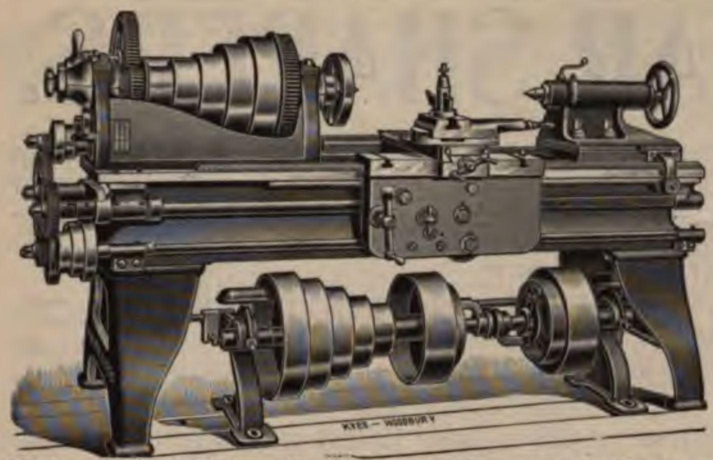

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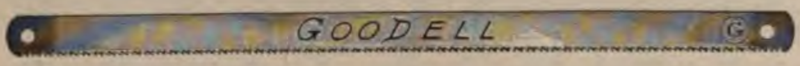
# See those Teeth?



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Garvin Machine Co., Berlin, Germany, and Austria.

New York City, Garvin Machine Co., Manning, Maxwell & Moore.

Boston and Chicago, Hill, Clarke & Co.

Style E. One of four styles.

ESTABLISHED 1875.

## Stow Mfg. Co.

**Binghamton, N. Y.**

INVENTORS.

Oldest and largest manufacturers in the world of the

## Stow Flexible Shaft

for all purposes.

**We make a very large line of Portable Tools.**

GENERAL
EUROPEAN
AGENTS:

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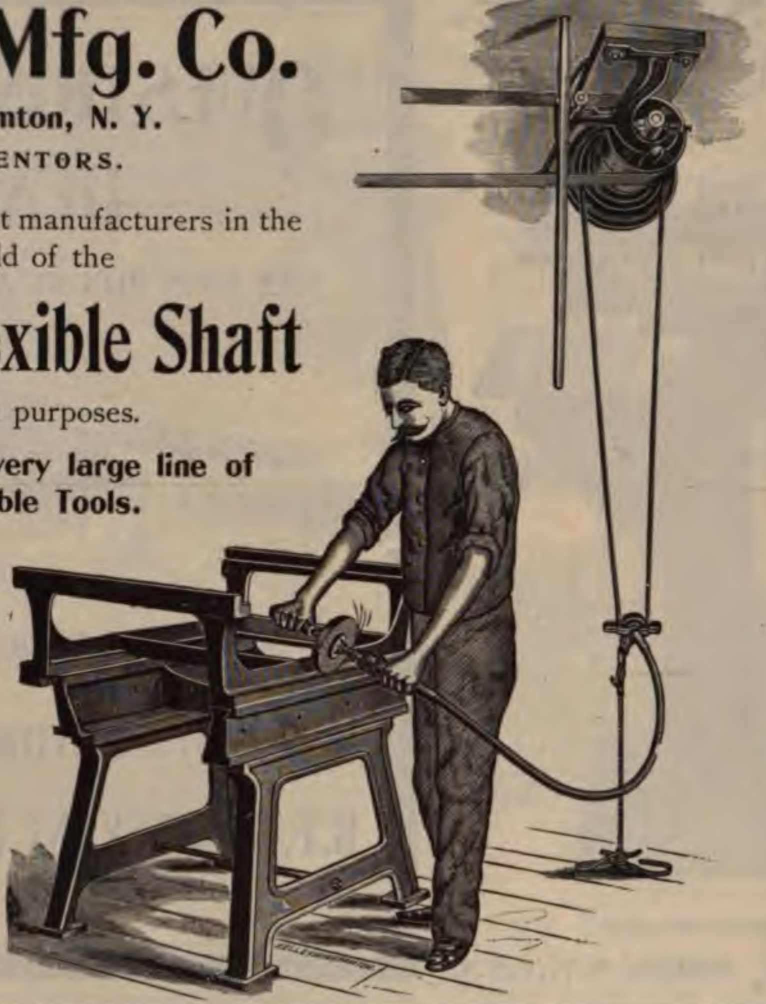
Sonnenthal
& Co.,

85 Queen
Victoria St.,
London,
England.



## PORTABLE EMERY GRINDER.

❦

**Are your castings HEAVY?**

**This tool is LIGHT.**

❦

**Take the TOOL to THE WORK instead of the WORK to THE TOOL.**

❦

**THOUSANDS IN USE.**

Write for catalogue and price list.

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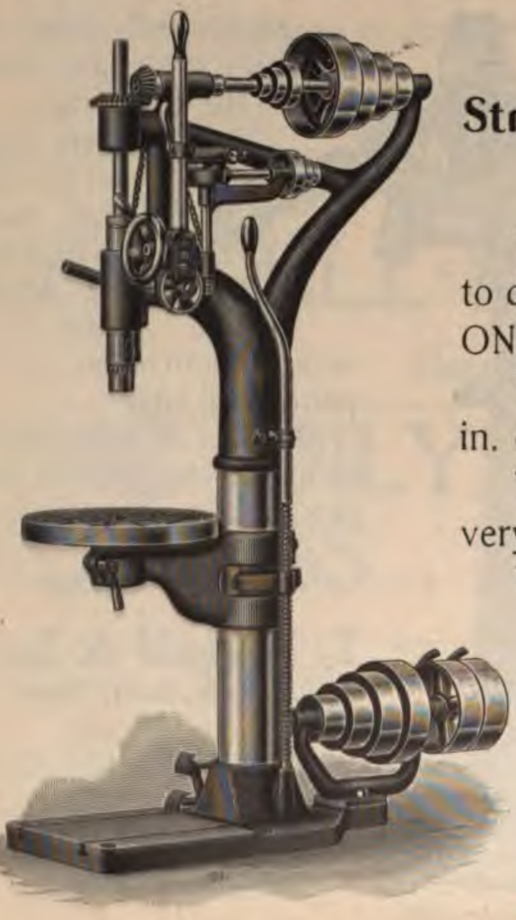
# THE B. F. BARNES UPRIGHT DRILLS.



## 20th CENTURY TOOLS.

**Strong, well built, and up-to-date in every particular.**

The cut shows our 20-in. drill which we guarantee to drill up to ONE INCH IN STEEL AND ONE AND ONE FOURTH INCHES IN CAST IRON.

We believe it is just a little ahead of any other 20-in. drill on the market.

The next size, 23-in. swing, is about ready for delivery. Will show cut next month.

We shall be glad to send you printed matter.

## B. F. BARNES COMPANY,

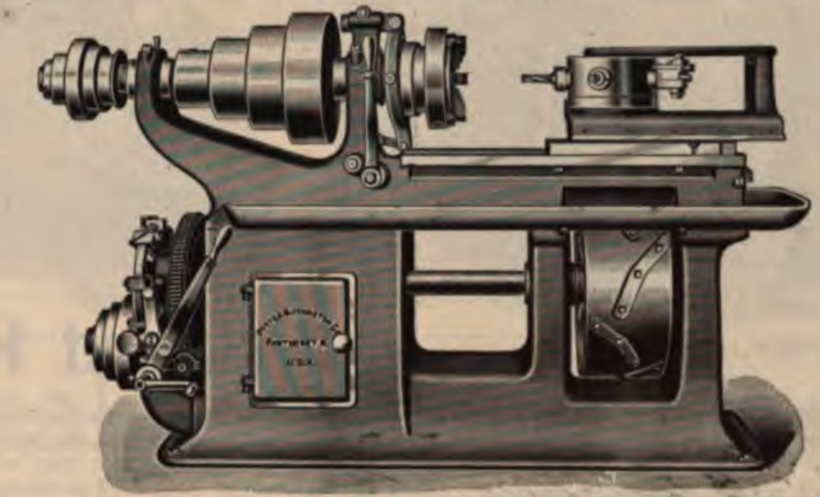
**ROCKFORD, ILLINOIS.**

AGENCIES: Hill, Clarke & Company, Boston. Prentiss Tool & Supply Company, New York. The Pratt & Whitney Company, Chicago. The U. Baird Machinery Company, Pittsburg. Morton, Reed & Company, Baltimore. Patterson Tool & Supply Company, Dayton. O. L. Packard Machinery Company, Milwaukee.

**Manufacturing Automatic**

# CHUCKING MACHINE

**With Patented Lever Chuck and Revolving Drill in Turret.**



The machine above illustrated is well adapted for the rapid production of small collars, bushings, gears, pulleys, etc., and will handle castings up to 4 inches in diameter and 4½ inches long. One man can run from 4 to eight of these machines, according to the class of work being done. Machine is fitted with our patented Lever Chuck, which enables the operator to change the work while the machine is IN MOTION. There is one 2⅛ inch hole through the spindle. The turret has five 2½ inch holes; one of the holes carries a rovolving drill which runs in an opposite direction to the headstock spindle, and is arranged with change gearing to give the proper cutting speed to drills up to ¾ inches diameter; the drill only revolves when in alignment with the spindle.

**POTTER & JOHNSTON CO., Pawtucket, R. I., U. S. A.**

**New York Office, 126 Liberty Street, Walter H. Foster, Manager.**

FOREIGN AGENTS:—Charles Churchill & Co., London, Birmingham and Manchester, England, and Glasgow, Scotland. Gustav Diechmann & Sohn, Berlin, Germany, and Vienna, Austria. Adolphe Janssens, Paris, France, and Brussels, Belgium. V. Lowener, Copenhagen, Denmark and Stockholm, Sweden.

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GAY & WARD.
Formed Milling Cutter.

# Milling Cutters

## and Similar Tools.

We manufacture this class of tools exclusively and have equipped our works with the latest improved machinery for their production. Our Cutters are made from original designs, of the best quality of steel, and constructed under careful supervision.

* * * *

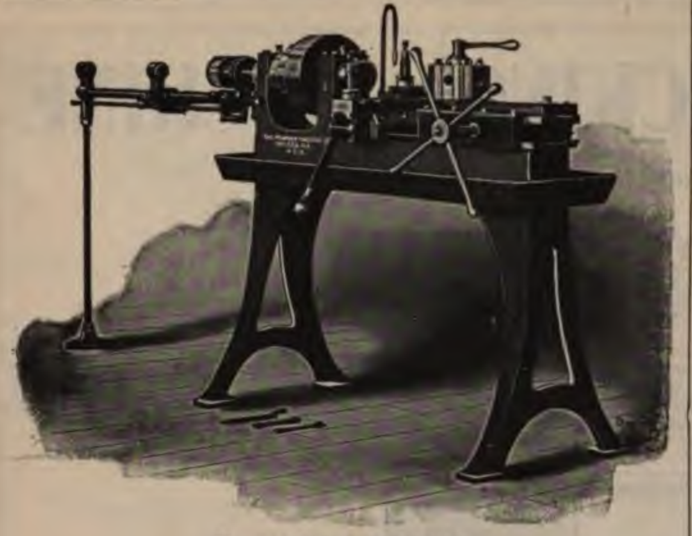
End Mills.

Send us a trial order, and compare the quality of our goods with those you are now using. Our line includes Cutters for Gear Wheels, Twist Drills, Taps, Reamers, and Irregular Formed Cutters which can be sharpened by grinding without-changing the form. Side Milling Cutters, Metal Slitting Saws, Angular Cutters, End Mills, Screw Slotting Cutters, Etc.

**Sold by most prominent dealers throughout the world.**

Patent Involute Cutter.

## GAY & WARD, Athol, Mass., U. S. A.



No. 3 SCREW MACHINE.

## Our New Screw Machine

DOES the work of several engine lathes and does more and better work than any other tool of the kind in the market. The design is entirely new and comprises every improvement that saves time and reduces cost in the work. Built in eight different sizes and capacities.

CABLE. "PEARSON," CHICAGO. LIEBER'S CODE.

**The Pearson Machine Co.,** 31 West Randolph St.
Chicago, Ill., U. S. A.

Walter H. Foster, 196 Liberty St., New York and "The Bourse", Philadelphia. McDowell, Stocker & Co., Chicago. The E. A. Kinsey Co., Cincinnati, Ohio. S. M. York Co., Cleveland, Ohio. Chandler & Farquhar, Boston. A. B. Pitkin Mch'y. Co., Providence. Markt & Co., 198 West St., New York, London, Hamburg, Paris, Sole European Agents.

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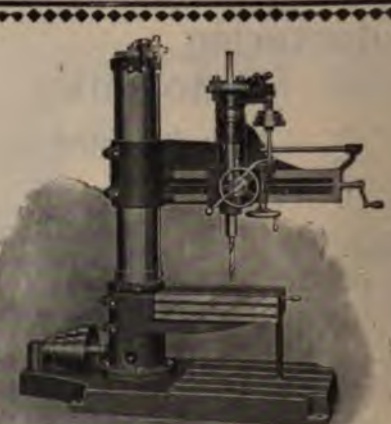

## Bickford Radials

are in such demand that we have not had one in stock in three years—notwithstanding the fact that we are building them at the rate of 36 machines per month. Your order should therefore be placed promptly, for the 216 scheduled to be finished during the balance of the year, 114 are already sold.

**The Bickford Drill & Tool Co.**
Cincinnati, Ohio, U. S. A.

FOREIGN AGENTS: **Berlin, Vienna, Brussels, Cologne, Stockholm, St. Petersburg,** Schuchardt & Schutte. **London, Birmingham, Manchester, Glasgow.** Chas. Churchill & Co., Ltd. **Paris, France,** Adphe Janssens. **Yokohama, Japan,** F. W. Horne.

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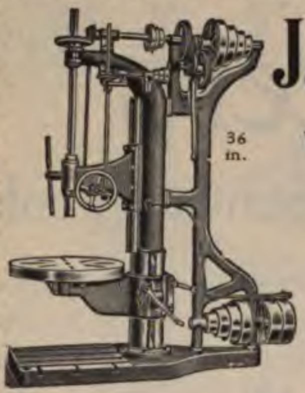


36 in.

## J. E. Snyder,

Worcester, Mass., U. S. A.

Builder of

## Upright Drills ONLY.

For Accuracy, Strength, Capacity and Durability, these drills are all O. K. Every drill personally inspected before it leaves the Works, and is ready for use when you receive it. When you buy, buy the best, and you will be happy. Hear what our customers have to say.

Rochester, N. Y., October 14, 1899.

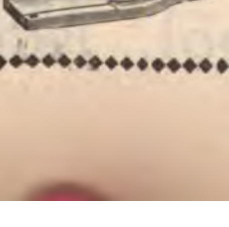
J. E. SNYDER, Worcester, Mass.

Dear Sir:—We have now in use one 20 inch drill press, two 30 inch and one 36-inch drill press of your make in our works, and take great pleasure in stating that we consider them the best drill presses we have ever used or seen. We can do more work and do it easier and better than on any other machine of same kind we have ever used.

They cost nothing for repairs, although in constant use, often 12 hours per day for years, and should we require more drill presses we should certainly buy the Snyder drill. You are at liberty to refer to us at any time. Yours truly,

The J. S. Graham Machine Co.
John Kane, Vice-Pres.

25 in.



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## Because

We pay union wages for the *making* is the reason *you* save money by *wearing* our

## Overalls and Coats.

They are built to stand up against *wear* and *work* longer than any other clothes made.

UNION MADE THE BRAND PANTS AND OVERALLS

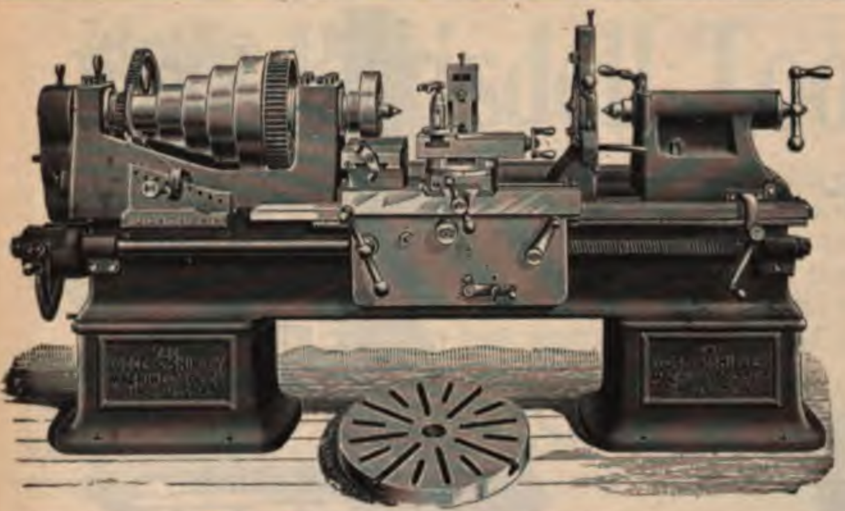
If your dealer does not keep these goods drop us a postal card and we will send you samples of cloth, self-measurement blank and tape measure free. Will sell you direct and prepay all charges.

**Hamilton Carhartt & Co.**

The firm that's making UNION-MADE Clothing popular.

*Detroit, Mich.*

**FREE** for the asking, our Illustrated Time Book, if you mention this journal.



# LATHES ONLY.

**14 in. to 42 in. Swing.**

We manufacture LATHES exclusively, and guarantee our tools to be unequalled for *Strength, Simplicity,* and *Range of work.*

**ALL THREADS AND FEEDS OBTAINED INSTANTLY.**

CATALOGUE ON REQUEST.

**THE LODGE & SHIPLEY MACHINE TOOL CO.,**

CINCINNATI, OHIO, U. S. A.

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# We make but one thing and we make that well.

We make TRY SQUARES and we make the best in the market.

The blades are made of the best Crucible Steel, accurately and solidly secured to the beams, and both blades and beams ground to templets so that all are alike and absolutely accurate.

Our Try Squares are hardened only in the process of grinding, which we have found sufficient for all practical purposes, and they will last a lifetime with ordinary care.

We put them up in sets of five Try Squares—an 8-inch, 6-inch, 4-inch, 3-inch and 2-inch—packed in a nice oak case, with hinged lid, as shown in illustration.

Price, complete, $6.50.

EVERY SET WARRANTED ACCURATE.

*GREBLE, TURNER & CO.,* *Hamilton, Ohio, U. S. A.*
*Works, Orange, Mass., U. S. A.*

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16 INCH BY 6 FEET.

# The "Cincinnati" Engine Lathe.

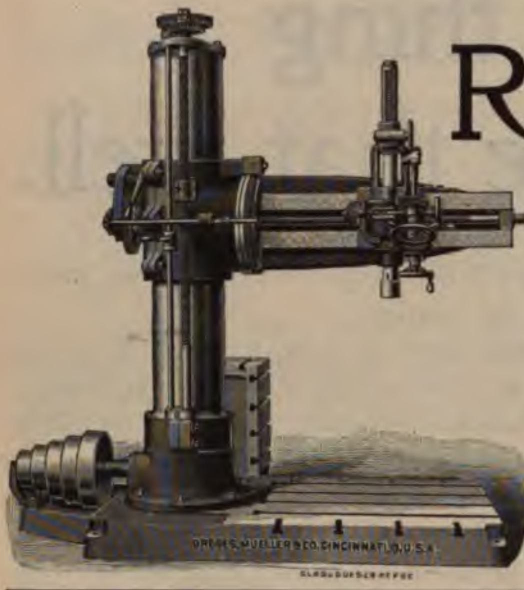
**A GOOD TOOL at the RIGHT PRICE.**

**16, 18 and 20 Inch.**

If in need of a lathe let us tell you about this one.

**SILK, ANDERSON CO.,**

429-431 East 2d St., CINCINNATI, OHIO, U. S. A.



A full line of Plain, Half and Universal

RADIAL DRILLS.

One **Lever,** always in reach of the operator, **starts, stops, engages the back gears** and **reverses** the **spindle quickly** for **tapping** without resorting to the belt shifter.

No rattling clutches. Positive working self-adjusting friction.

**Dreses, Mueller & Co.** Cincinnati, Ohio, U. S. A.

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PACIFIC TOOL & SUPPLY CO., San Francisco.
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VAN RIETSCHOTEN & HOUWENS, Rotterdam.
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STÜSSI & ZWEIFEL, Milan, Italy.

**A SURE THING IS WORTH LOOKING AT.**

You know CLING-SURFACE. We want you to use it. You can't lose anything when we ask a trial order on these terms: You to test it at home in your own belts—the worst one if you like. Decide on it yourself. Pay for it only if it proves itself worth your money.

Write now.

CLING-SURFACE MFG. CO.,
153-159 Virginia Street,
Buffalo, N. Y.

**Use nothing but Corrugated Ridge and Hip Capping for Corrugated Roofing.**

Saves Corrugated Wood Strips, Saves Time, Saves Money.
Furnished to fit different corrugations.

LARGE STOCK. LOW PRICES. PROMPT SHIPMENTS.

SEND FOR CATALOGUE FOR 1897.

All Styles of Iron and Steel Roofing and Siding, also Fire-proof Doors and Shutters.

**THE GARRY IRON & STEEL ROOFING CO.,** 178 TO 192 MERWIN ST., CLEVELAND, OHIO.

# Blaisdell Tools.

Up-to date in every particular; latest improvements embodying all essentials necessary to produce strength and durability. *Lathes* from 13 in. to 31 in. swing, extra large spindle bearings, cutaway tail stock, automatic stop. *Patent Upright Drills*—20 in., 25 in., 28 in., 30 in., 36 in., 45 in. and 50 in. Powerfully back geared with power feed and quick return motion; balanced spindle and automatic stop.

**Send for 1900 Catalogue.**

**P. BLAISDELL & CO.,** Worcester, Mass., U.S.A.

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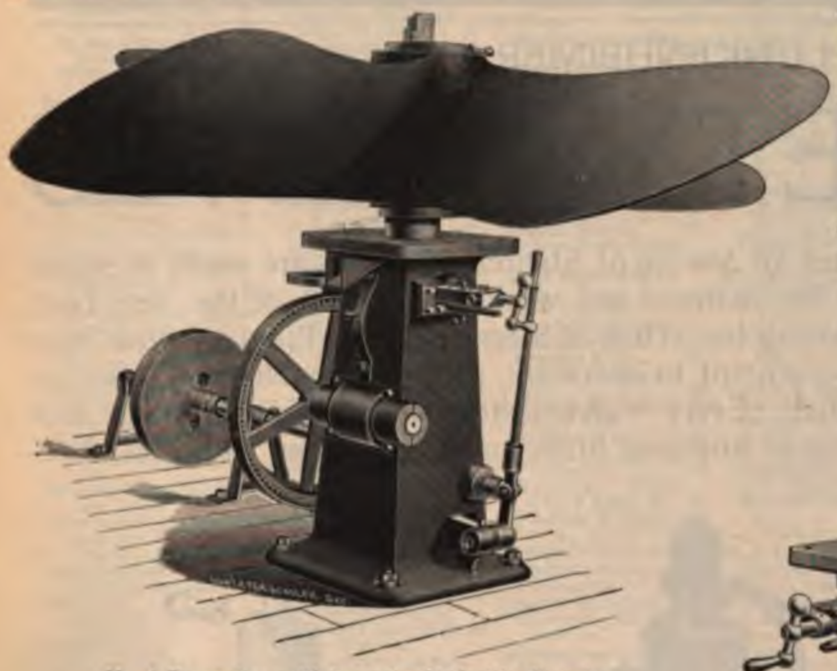
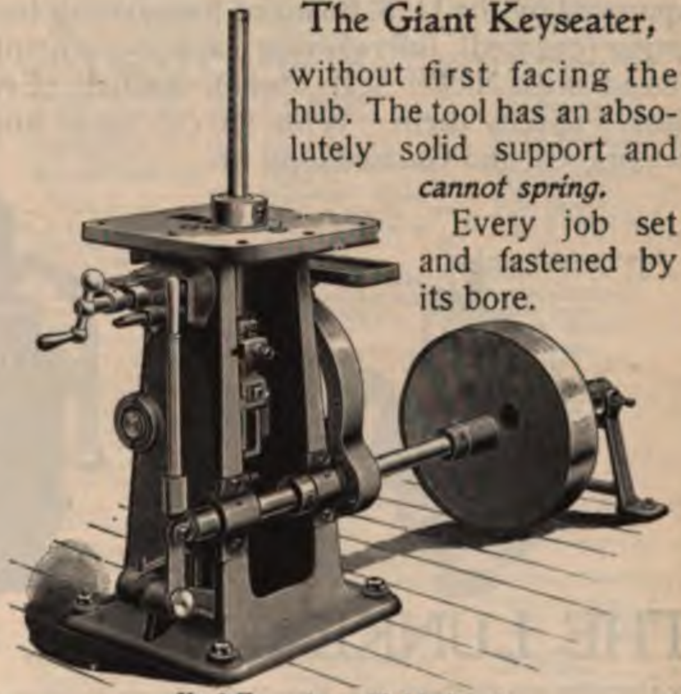
# Perfectly Accurate....



*No. 3 Keyseater, with tug wheel 7 feet in diameter.*

Keyseats can be cut with the **The Giant Keyseater,** without first facing the hub. The tool has an absolutely solid support and *cannot spring.* Every job set and fastened by its bore.



*No. 2 Keyseater, with 1 inch post.*

The Giant can be very quickly adjusted for different requirements, and will finish two ordinary keyseats before one piece can be fastened ready for keyseating on other style machine. Will cut straight or taper keyseats.

*Send for Keyseater book.*

**MITTS & MERRILL,** 843 WATER ST., SAGINAW, MICH., U. S. A.

FOREIGN AGENTS: C. W. Burton, Griffiths & Co., London, England. Gustav Diechmann & Sohn, Berlin, Germany. Penrhyn Neville, Milano, Italy.

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# Air Compressors, Air Appliances, Air Hoists.

8x8 Compressor, Single Stage.

All our machines are designed after careful and systematic experiment, and built in specially equipped shops. Circulars and specifications furnished on request. Write us about our new line of Pneumatic and Hydro-Pneumatic Elevators and Hand Cranes, capacity up to 10,000 pounds, 30 foot span.

**Curtis & Co. Mfg. Co., St. Louis, Mo., U. S. A.**

REPRESENTATIVES: Walter H. Foster, 126 Liberty St., New York. U. Baird Machinery Co., Pittsburg, Pa. H. Glaenzer & Perreaud, Paris, France. U. S. Metallic Packing Co., Bradford, Eng.

# LEATHER FOR THE RHOADS BELT

is carefully selected and well stretched. The Belts are Fully Guaranteed. Write to us for price. It is low.

**J. E. RHOADS & SONS, 239 Market St., PHILADELPHIA, PA.**

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THE LUNKENHEIMER

# POP SAFETY VALVES

All Brass and Iron Body, Brass Mounted for Marine or Stationary Boilers are made in screw or flange ends from 2 and 6 inches. The material and workmanship are of the very best. Approved by the U. S. Board of Supervising Inspectors of Steam Vessels. Provided with large spring (encased), full relieving capacity, prompt in operation, and always reliable. Also furnished with Nickel Seats, when desired. Every Valve tested and warranted strictly first class. Specify them. Write for catalog of Superior Brass and Iron Valves, Whistles, Lubricators, Oil and Grease Cups, etc.

**THE LUNKENHEIMER CO.,** MAIN OFFICE AND WORKS, CINCINNATI, OHIO, U. S. A.

BRANCHES: 26 Cortlandt St., New York. Bourse Building, Philadelphia. Puente de S. Francisco, No. 6, Mexico City. 35 Great Dover St., S. E London.

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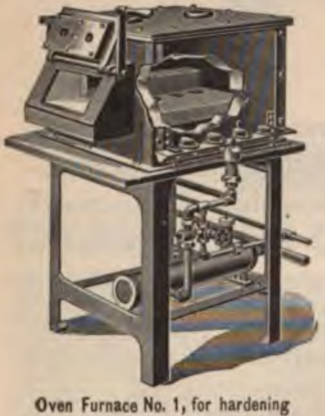
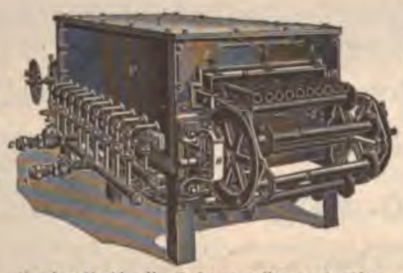
# UNIFORMITY AND ECONOMY IN HEATING

**can best be obtained by using our Heating Machines, which are a combination of Gas Heated Furnaces with mechanical devices for feeding and discharging work, accurately heated to the exact degree required and with perfect uniformity both as to time of heating and degree of heat. We illustrate herewith two styles of the different Gas Forges, Furnaces, and Heating Machines we manufacture, and will be glad to mail catalogue on application.**



Oven Furnace No. 1, for hardening and annealing.



Heating Machine No. 7, for annealing steel tubing.

**American Gas Furnace Co.**
23 John Street, New York.

Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow. H. Glaenzer & Perreaud, Paris. Schuchardt & Schutte, Berlin, Cologne Vienna, St. Petersburg.

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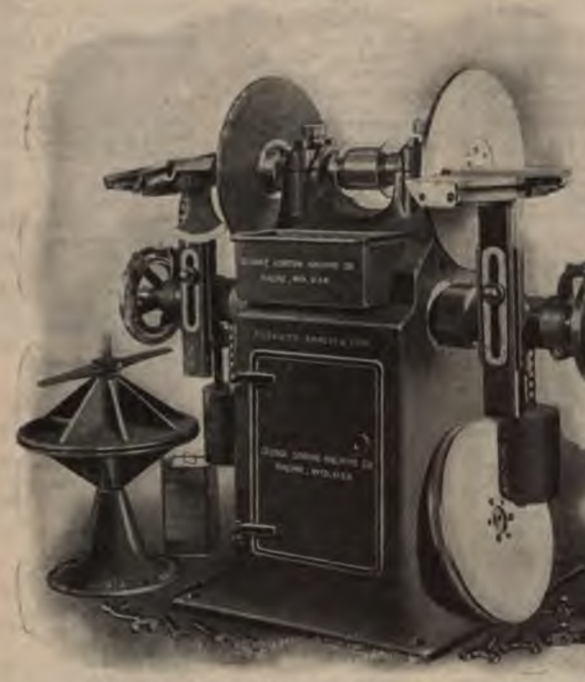

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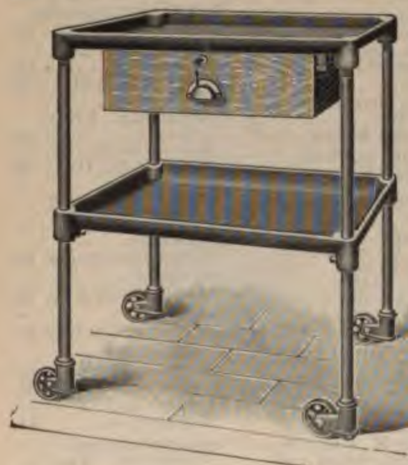

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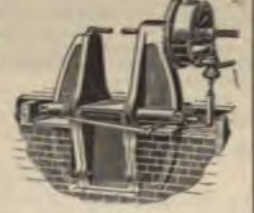

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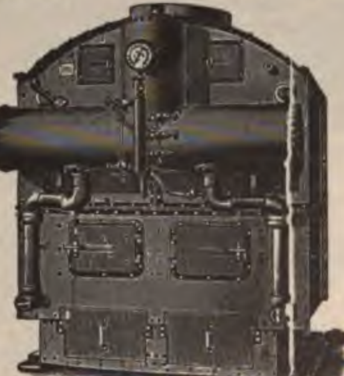

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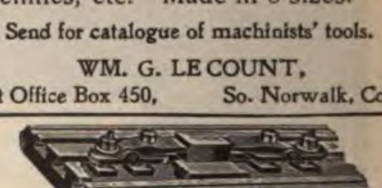

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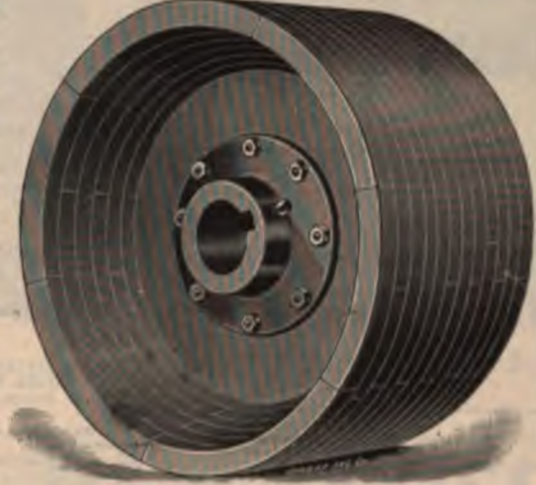
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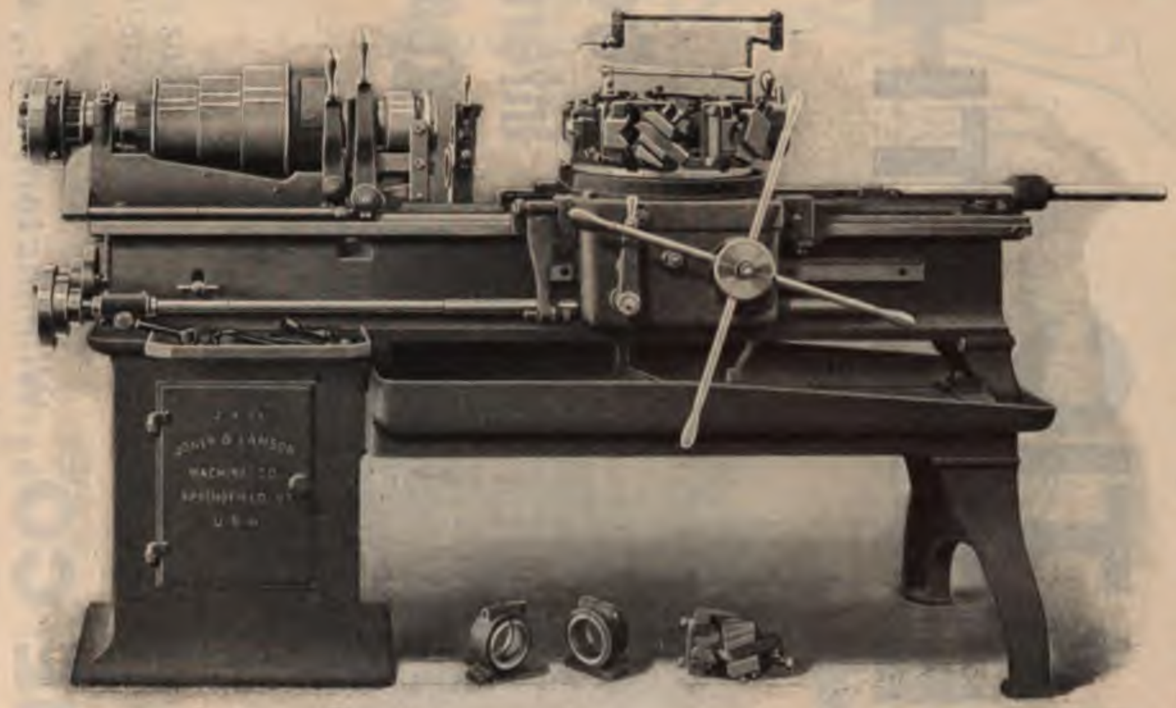

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**For the Rapid and Accurate Production of Lathe Work**

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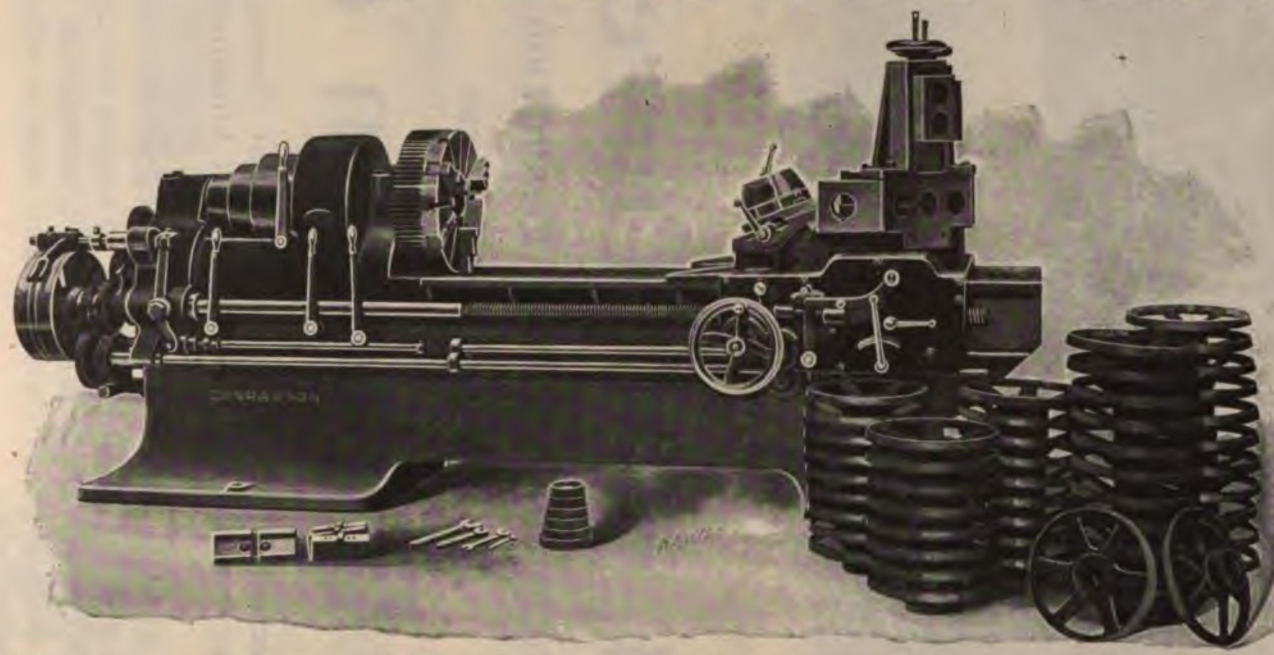

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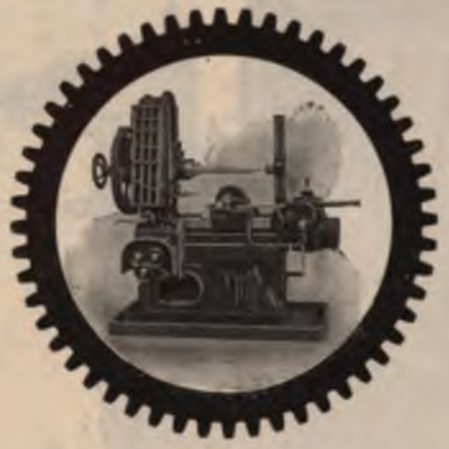

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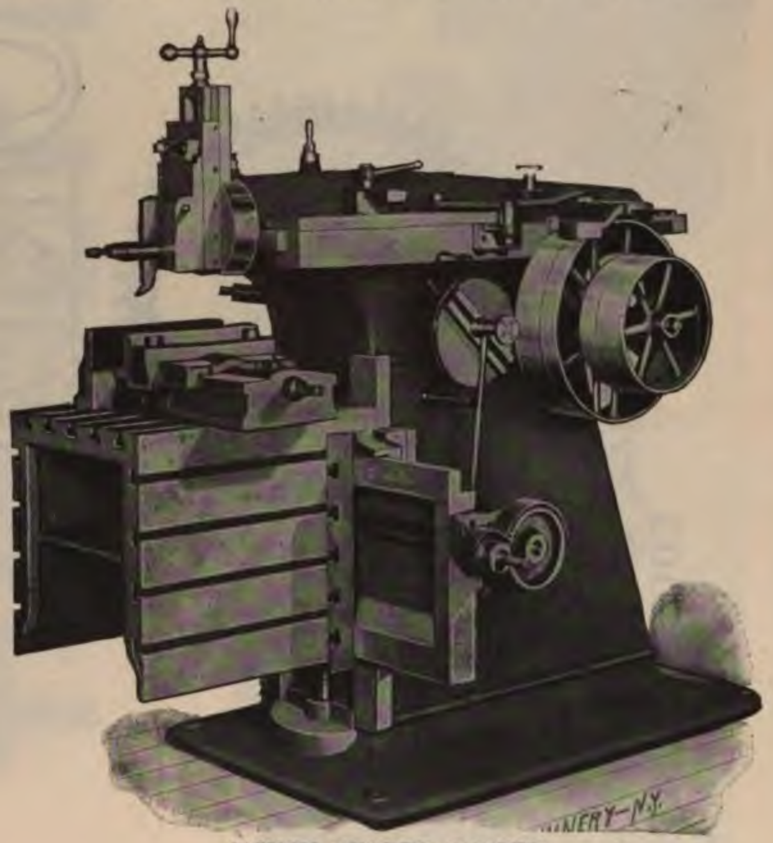

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Dividing head and quick return crank placed on same end of table so that no time is lost in moving cutter to and from the work.

Cup shaped plate on Dividing Head provides for revolving dividing head spindle direct, in spacing small work.

Vertical Shaft placed at oblique angle, so that operator may make two adjustments simultaneously without changing his position.

Operating handles made in clutch form to suit position most convenient to operator.

Dividing head may be quickly set at any angle and when set, clamping has no tendency to move it.

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*Our 1900 Catalogue A will give you others.*

**The Cincinnati Milling Machine Company,**
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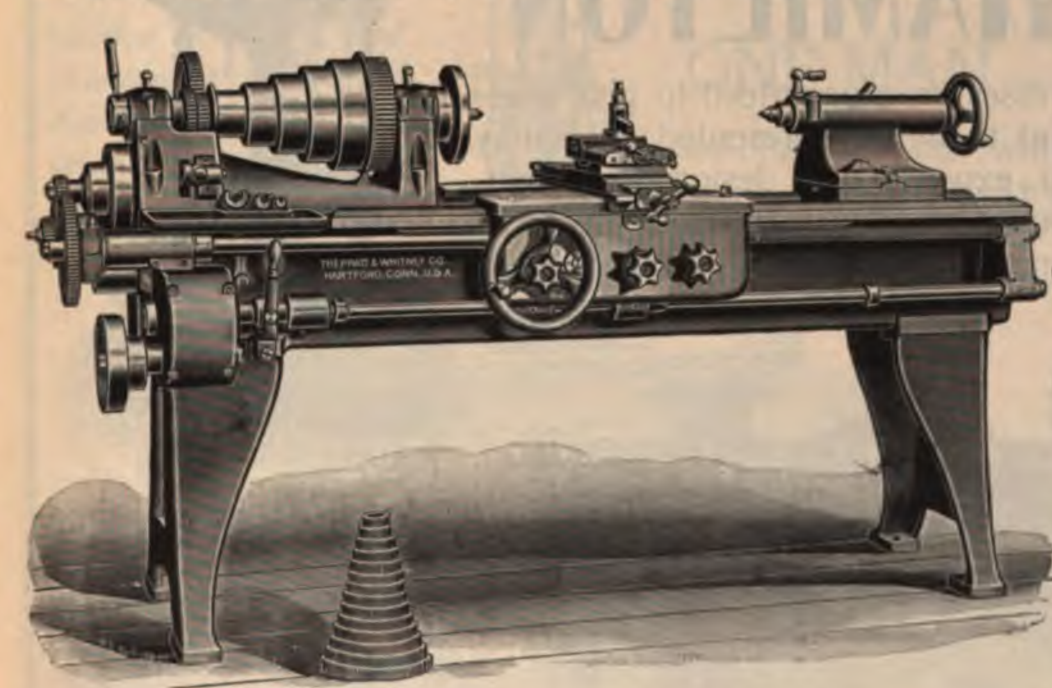

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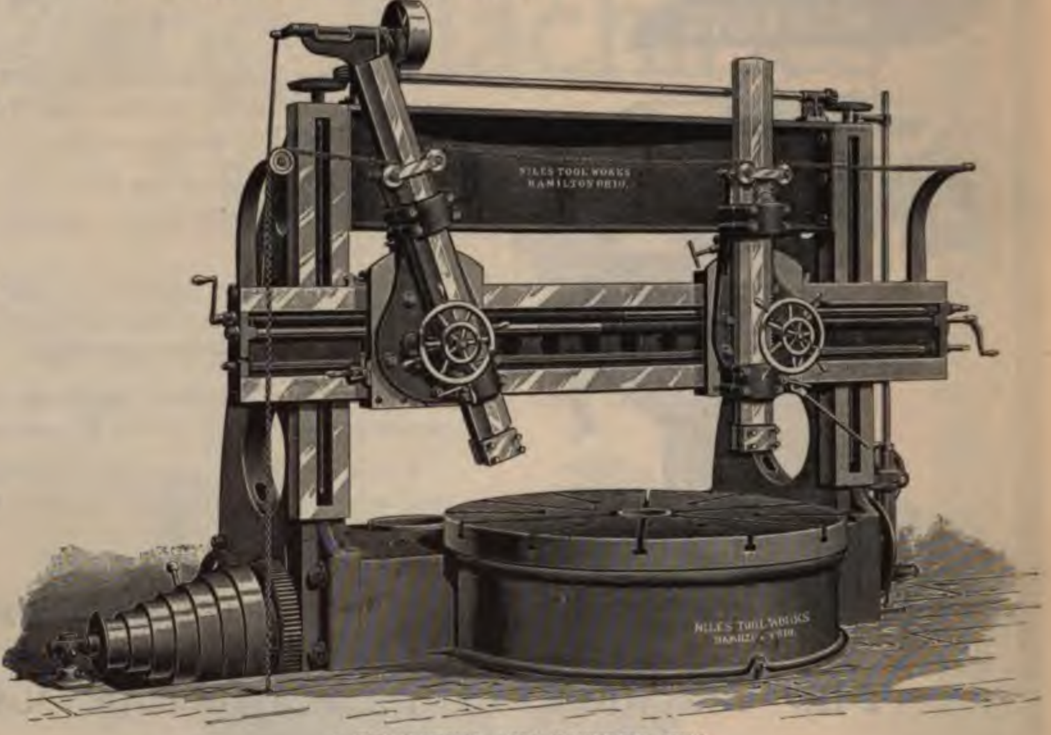
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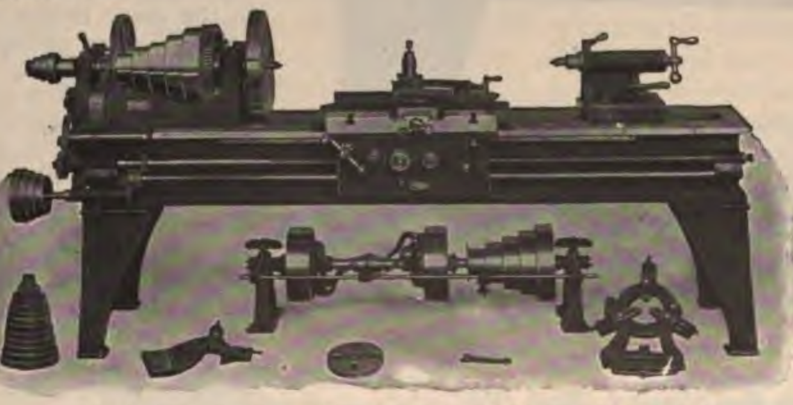
Lathes and Drill Presses are guaranteed to give satisfaction—if not found to be as represented, they may be returned at our expense. In design these machines are of the most improved and modern type, and the workmanship throughout of the highest character.



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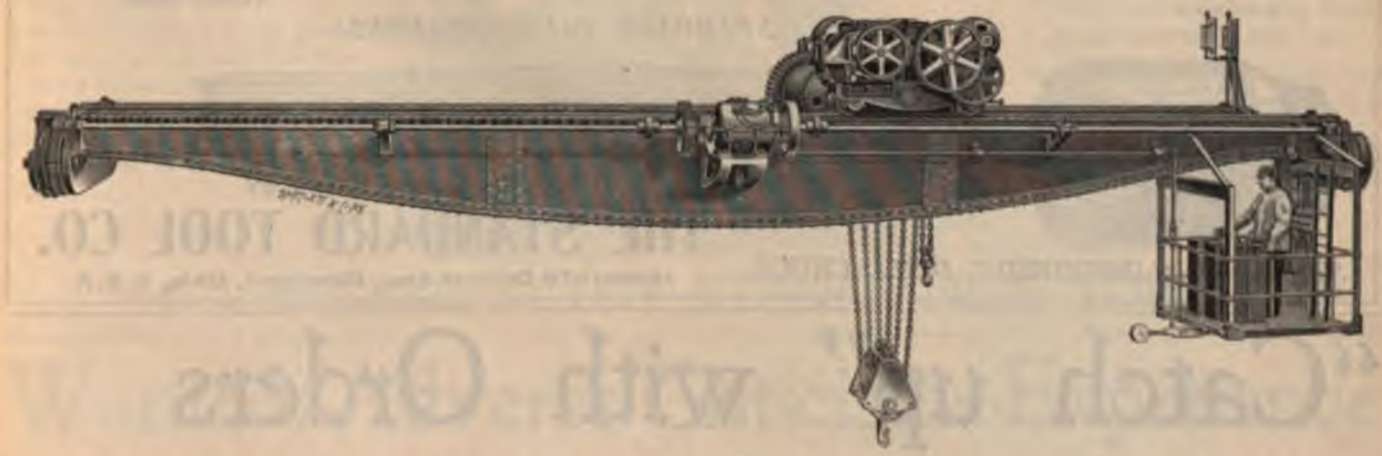

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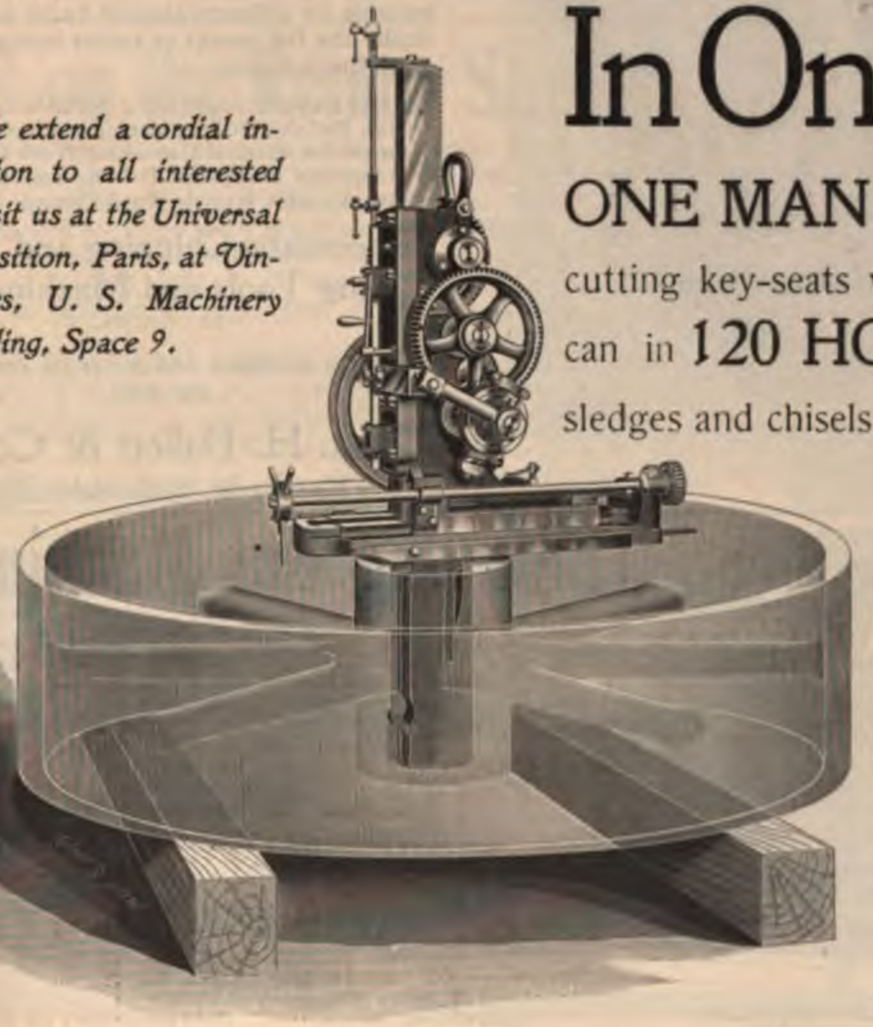
*We extend a cordial invitation to all interested to visit us at the Universal Exposition, Paris, at Vincennes, U. S. Machinery Building, Space 9.*



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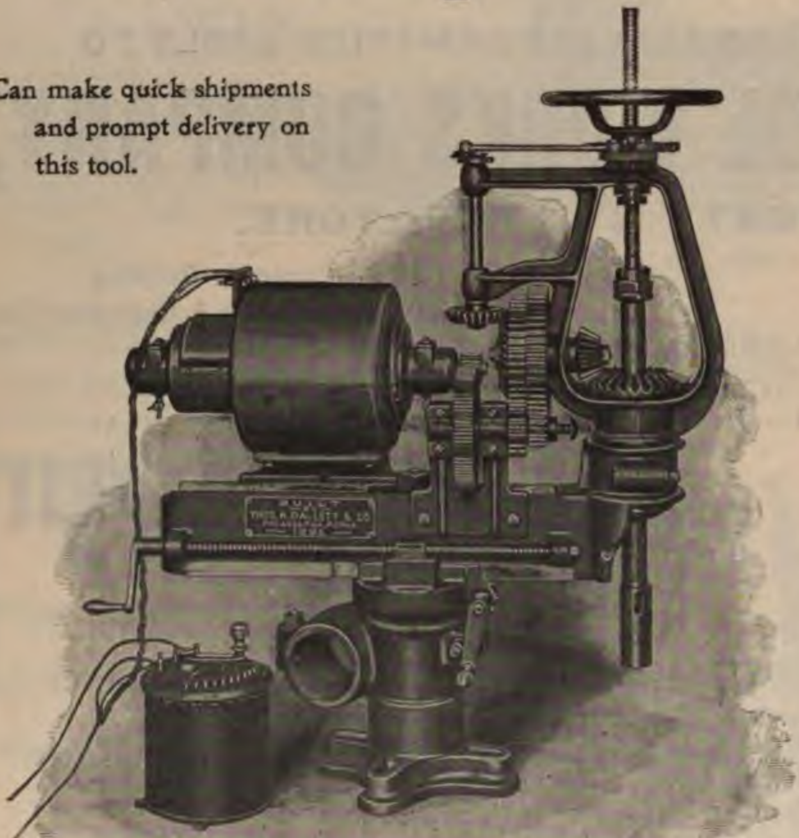
## and Increase the Capacity of your shop . . .

Can make quick shipments and prompt delivery on this tool.



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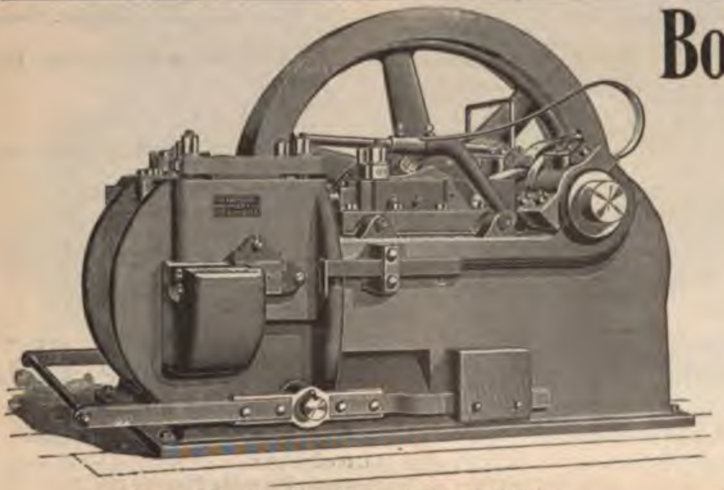

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**Bolt Cutters. Nut Tappers.**
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**Forming and Bending Machines.**
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Represented in European Countries by leading machinery dealers.

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# McCABE'S PATENT DOUBLE SPINDLE LATHE

Combines two complete Lathes in One

A 26-INCH SWING Back geared 11 to 1 for doing the common range of work.

A 44-INCH SWING Triple geared 22 to 1 or with Geared Face-plate 66 to 1 for doing the heaviest classes of work up to the full swing.

Swings as much over the carriage (39 inches) as in regular 54-in. lathe.

Has Hollow Spindle 2⅛in. hole and WIDER RANGE of SPEEDS, FEEDS and thread-cutting capacity than any regular style Lathe.

Adapted for all classes of work, both large and small, and costs but little more than an ordinary size lathe.

Send for catalogue and see the list of shops that have them.

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We want you to tell us how the press you have could be improved to do your own particular class of work better, or how to change the press so it would become even more popular in the shop.

**What are the disadvantages? Where are the weak places?**

*NAPOLEON SAID:—"Tell the bad news first: the good can wait."*

Awaiting an early reply, we are, Yours for progress,

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The Challenge Power Hack Saw has a positive feed on the forward stroke, but the blade is automatically relieved on the return stroke, thus preventing dragging over the work. The Machine is also provided with adjustment for sawing to a depth, which permits it to be used for SLOTTING as well as CUTTING OFF.

**SAWS METAL UP TO 6 INCHES.**

**Price, including six saws, $50. Write for circulars.**

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THE PATTERSON TOOL & SUPPLY CO., Dayton, Ohio.

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Yours truly, The Geo. Burnham Co., Per F. R.

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Iron and Brass **Castings.**

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Steel Gear Blank. 4½ lbs.

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OF EVERY DESCRIPTION

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Universal
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Gives any angle to point of drill.
Also any clearance to cutting lip.

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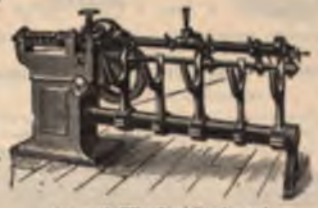

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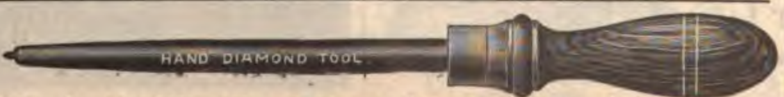

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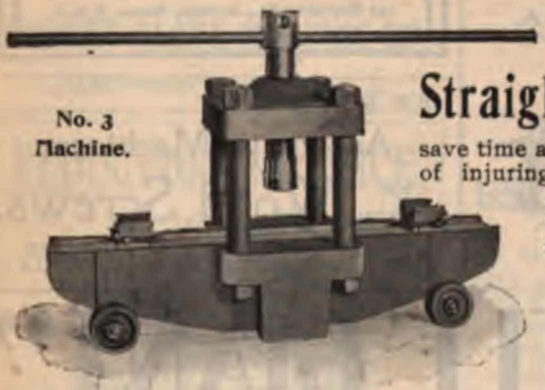

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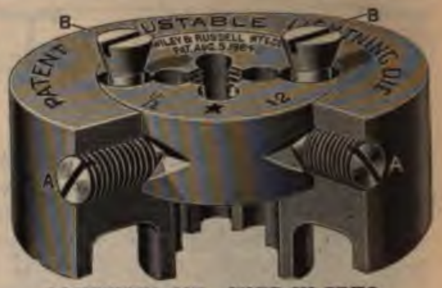
DIES ALWAYS READY TRUE TO SIZE
PERFECT SCREWS AT A SINGLE CUT.



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Automatic Machinery for making **Wood Screws.**

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NEW LITTLE GIANT SCREW PLATE
WITH STOCKS FOR EACH SIZE
AND
ADJUSTABLE TAP WRENCHES
THESE CASES ARE MADE WITH REMOVABLE TRAYS
THEY CONTAIN ADJUSTABLE TAP WRENCHES

# "LITTLE GIANT"

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**Great Variety of Sizes.**

YOU MAKE NO MISTAKE WHEN BUYING OUR TOOLS.
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Tapping,
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Brass and Iron Machine Screws.
Nuts and Washers.
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For marking neatly and quickly either round or flat work.

Twist drills and taps marked at the rate of 12 to 20 a minute.

Table Knives, 600 dozen marked in ten hours, and other work in proportion.

Will mark Letters, Numbers, Trade-Marks, etc., by the use of Steel Dies.

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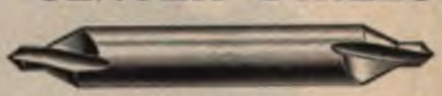

for centering your lathe work. They save time by doing at one operation, that which otherwise requires two.

Tools for centering lathe work are not very expensive, but the time wasted in using inconvenient tools often amounts to more that their cost.

They will center a piece after the old centers have been nearly squared out, so the work will run very near the same as on the original centers.

They are just the thing for a centering machine, as the drill being short and stiff, more readily finds the true center than when a common small drill is used.

They will not chatter under any condition, for the pressure on point of drill, and the drill generally, steadies the reamer.

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*Patterns of every description.*
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*Low Cost!*

BE WISE

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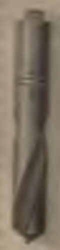

# Two worn out DRILLS

One by using.
One by slipping.

One held by a **PRATT CHUCK,** in which a drill cannot slip.

One held by other makes.

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**Emery Wheels, Corundum Wheels,**
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**The Walker Universal Tool and Cutter Grinder** will grind Cutters, Reamers, Cylindrical Work, internally or externally, straight or taper. A universal machine in every respect.

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Quick Cutting, Durable, Waterproof.

**NORTON MACHINES,**
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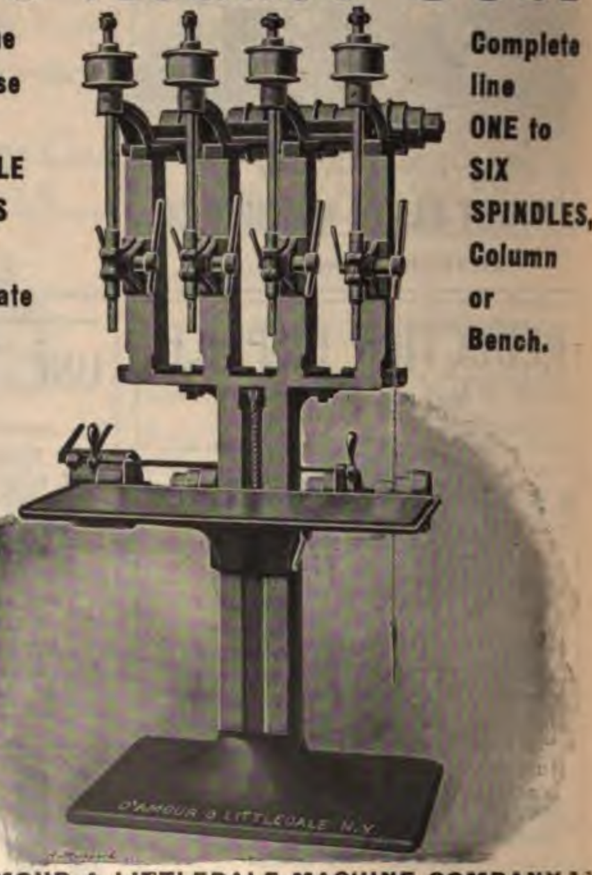
**use one of these FOUR SPINDLE DRILLS on duplicate work.**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bears the same relation to emery, corundum and other old fashioned abrasives.

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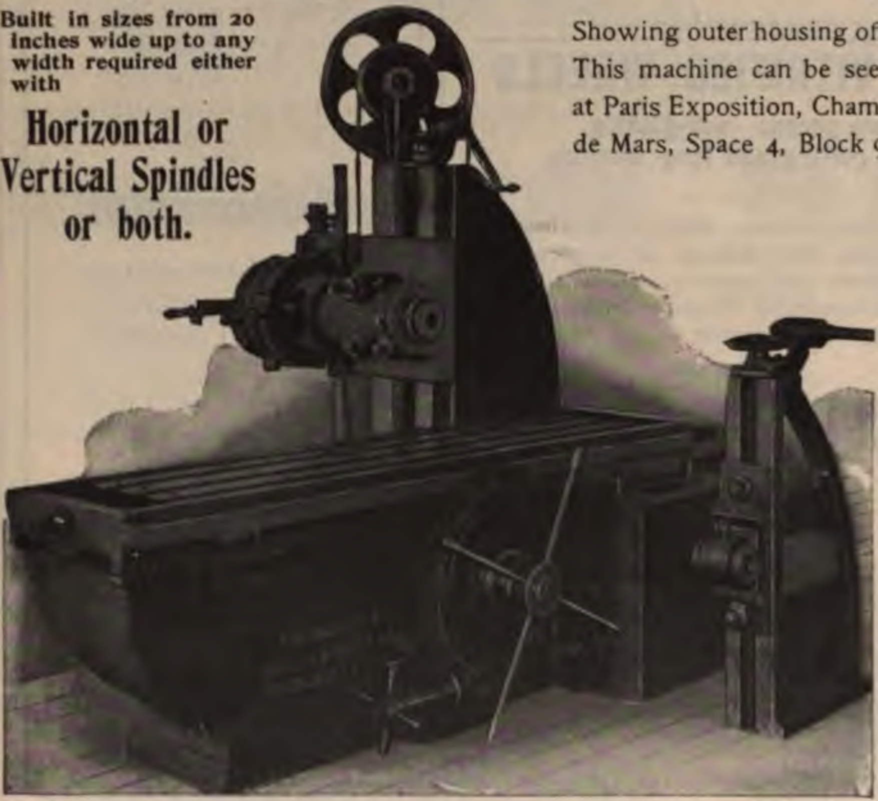

Standard 20 in. by 20 in. by 6 ft. Removable Housing Machine.

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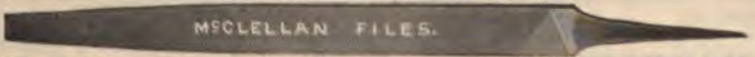
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LIKE CUT OR WITH TURRETS.

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**Combined with any Iron Planer.**

**Swivels from Horizontal to Vertical.**

Do not plane surfaces that should be milled, or mill surfaces that should be planed.

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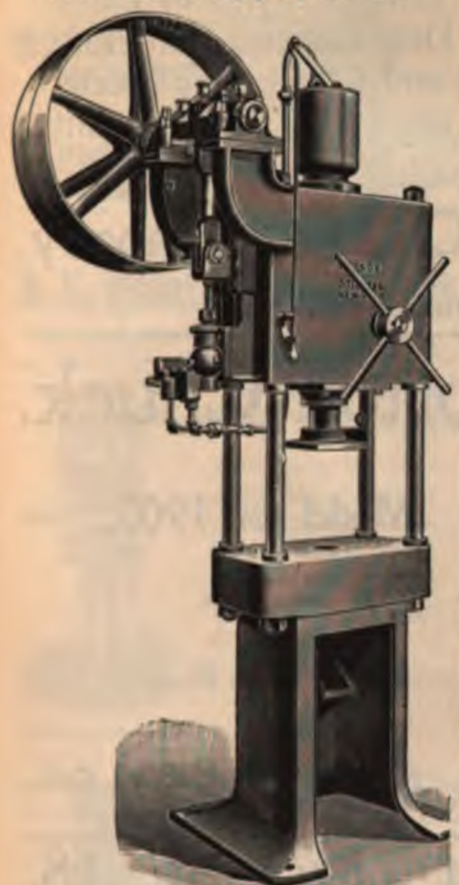

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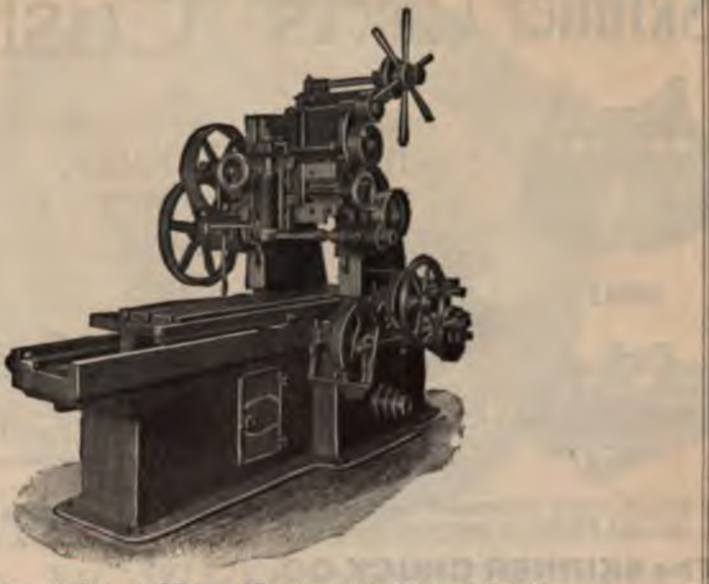

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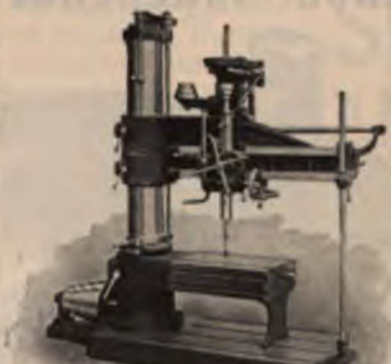

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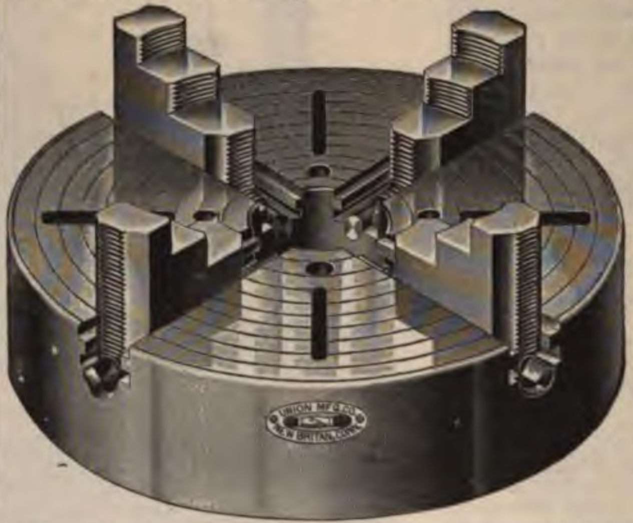

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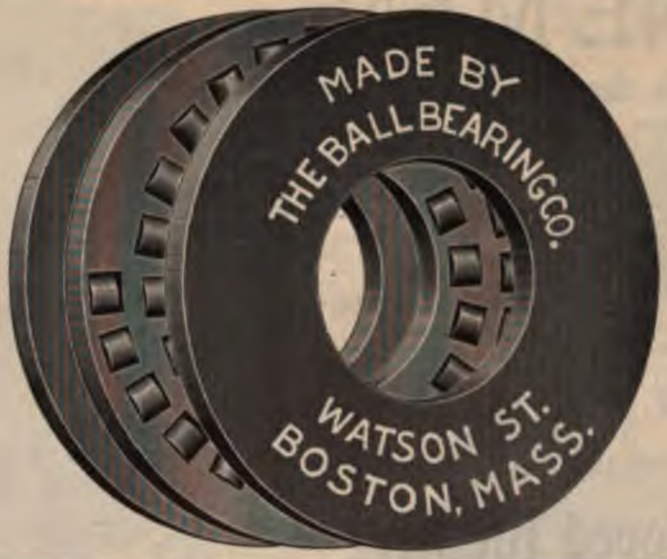
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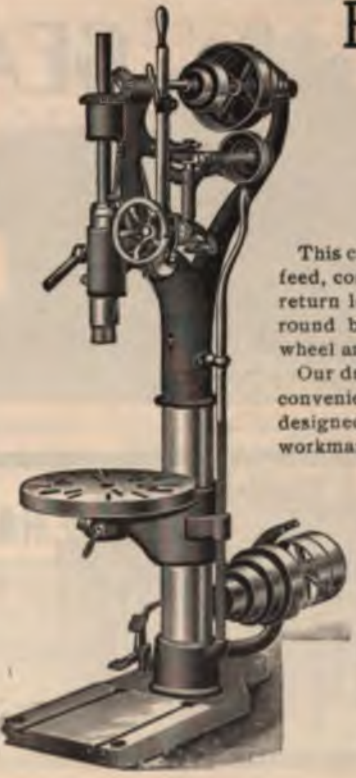

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8 in. to 42 in. Swing.

This cut represents our 20 in. Swing Drill with self-feed, lever feed, combined wheel and lever feed, automatic stop and quick return lever. We can furnish this drill with either square or round base, square or round table; plain lever or combined wheel and lever.

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can easily cut off and thread any size of pipe from 1-4 to 10 inches by hand power. Machines are readily portable.

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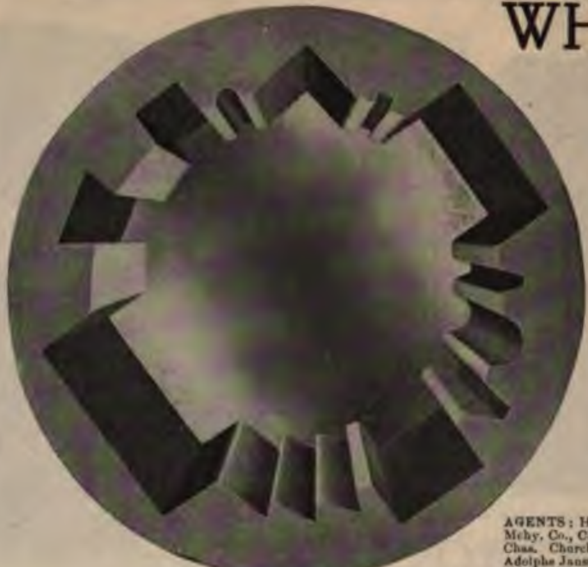

It is a sample of some of the work done on the Colburn Keyseater. All these cuts and many others can be made on this machine. All work chucked by the bore. Hubs need not be faced.

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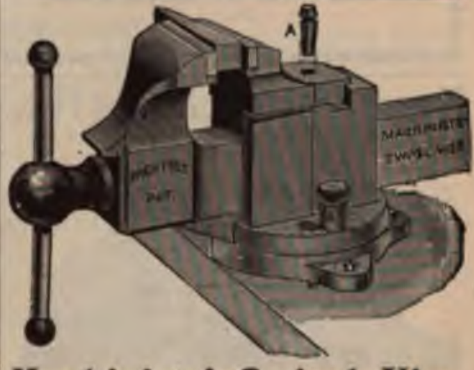

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with self-adjusting jaw that is as strong and durable as any solid jaw, and a Swivel Bottom that gives any desired adjustment to right or left, and is solid and firm at any angle. We make all sorts of good vises, and have been leaders in this line for twenty years. Send for catalogue and price list.

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One of these tools will do the work of a dozen forged tools.
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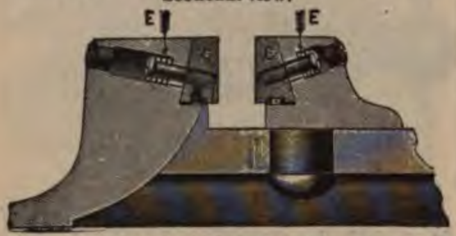

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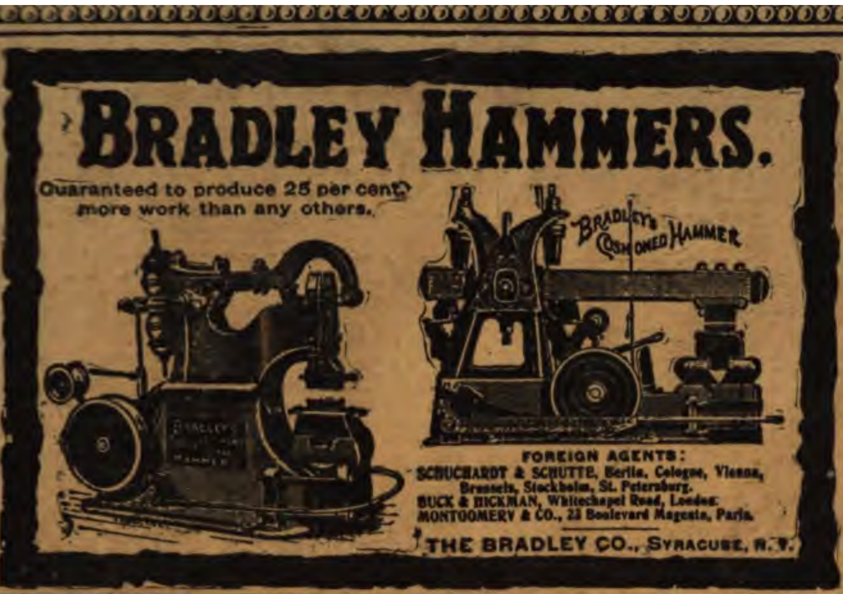

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